PB84-229590

Nationwide Urban Runoff Program, Oakland County, Michigan. Effective Stormwater Management Programs: Case Studies of Local Government Experiences in Southeast Michigan

Southeast Michigan Council of Governments
Detroit

Prepared for

Environmental Protection Agency
Washington, DC

Mar 81

U.S. Department of Commerce
National Technical Information Service
NTIS

50272-101

REPORT DOCUMENTATION PAGE

1. REPORT NO.

2.

PB84-229590

4. Title and Subtitle
Nationwide Urban Runoff Program, Oakland County, MI, EFFECTIVE STORMWATER MANAGEMENT PROGRAMS: CASE STUDIES OF LOCAL GOVERNMENT EXPERIENCES IN SOUTHEAST MICHIGAN.

5. Report Date
Mar, 1981

6.

7. Author(s)
Lillian F. Dean, Consultant for SEMCOG

8. Performing Organization Rept. No.

9. Performing Organization Name and Address
Southeast Michigan Council of Governments (SEMCOG)
8th Floor, Book Building
1249 Washington Boulevard
Detroit, MI 48226

10. Project/Task/Work Unit No.

11. Contract(C) or Grant(G) No.
(C)
(G) P 005423010

12. Sponsoring Organization Name and Address
EPA, Office of Water Program Operations
Water Planning Division
401 M Street, SW
Washington, D C 20460

13. Type of Report & Period Covered
Final

14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

Stormwater management planning, regulatory, and maintenance programs in five local jurisdictions in Southeast Michigan are described and compared with each other. A description of effective local stormwater management programs directed toward stormwater quality and quantity control provides a basis for the assessment. Case study reports are presented to assist local governments with program development efforts.

17. Document Analysis a. Descriptors

Hydrology
Urban development
Watersheds
Water pollution
Water resources
Sedimentation
Storms
Regional planning
Urban planning
Civil Engineering

b. Identifiers/Open-Ended Terms

Runoff
Streamflow
Stream pollution
Rainfall
Snowmelt
Soil Erosion
Water Quality
Sediments
Sediment Transport
Suspended Solids
Storm Drains
Urbanization
Land use

c. COSATI Field/Group

18. Availability Statement: No restriction on distribution. Available from National Technical Information Service, Springfield, VA 22161

19. Security Class (This Report)
UNCLASSIFIED

20. Security Class (This Page)
UNCLASSIFIED

21. No. of Pages
110

22. Price

(See ANSI–Z39.18)

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

OPTIONAL FORM 272 (4–77)
(Formerly NTIS–35)
Department of Commerce

ABSTRACT

TITLE: Effective Stormwater Management Programs: Case Studies of Local Government Experiences in Southeast Michigan

SUBJECT: Local Government Stormwater Management

AUTHOR: Lillian F. Dean, Management Consultant

DATE: March, 1981

LOCAL PLANNING AGENCY: Southeast Michigan Council of Governments

SOURCE OF COPIES: Southeast Michigan Council of Governments
800 Book Building
1249 Washington Boulevard
Detroit, Michigan 48226

NUMBER OF PAGES: 95

ABSTRACT: Stormwater management planning, regulatory, and maintenance programs in five local jurisdictions in Southeast Michigan are described and compared with each other. A description of effective local stormwater management programs directed toward stormwater quality and quantity control provides a basis for the assessment. Case study reports are presented to assist local governments with program development efforts.

EFFECTIVE STORMWATER MANAGEMENT PROGRAMS:
CASE STUDIES OF LOCAL GOVERNMENT EXPERIENCES IN SOUTHEAST MICHIGAN

March 1981

Prepared by
Lillian F. Dean
Planning and Management Consultant

for the
Southeast Michigan Council of Governments
800 Book Building
1249 Washington Boulevard
Detroit, Michigan 48226

Preparation of this document was financed in part through a planning grant from the U. S. Environmental Protection Agency.

PREFACE

The '208' *Water Quality Management Plan for Southeast Michigan*, adopted by the Southeast Michigan Council of Governments (SEMCOG) in 1979, includes the policy that "all new development shall be designed and managed to reduce stormwater pollutant loadings to receiving waters by best management practices." The use of stormwater detention in areas in which such a practice is compatible with local flood control practices is specifically recommended. (Plan policy IV.D.1.)

SEMCOG is currently conducting technical research to determine methods for increasing water quality benefits from detention facilities constructed for flood control purposes. The purpose of this report is to provide complementary technical assistance materials in the area of public administration and management.

This report documents the experience of five local governments in Southeast Michigan with stormwater management programs. Each of the five case study communities has a strong regulatory program for new developments. The case studies also provide useful examples of approaches to stormwater management planning and stormwater facility construction and maintenance. Guidelines for establishing local stormwater management programs are also recommended in this report. These guidelines provide a baseline for the analysis of the experience of the case study communities.

This report is intended as a discussion document for local officials concerned about stormwater management. Future reports in this stormwater management series will address legal authority for administrative approaches for implementing technical guidelines.

TABLE OF CONTENTS

Page

Abstract-- i

Title Page-- iii

Preface--- v

Table of Contents--- vii

List of Tables-- ix

List of Figures--- xi

CHAPTER I: INTRODUCTION TO LOCAL GOVERNMENT CASE STUDIES---------------- 1

Scope of the Report-- 3

Stormwater Quality Management-------------------------------------- 5

Stormwater Management Program Trends------------------------------- 7

Comprehensive Stormwater Management-------------------------------- 8

Functional Inter-Relationships with Stormwater Management- 9

Stormwater Management Program Components------------------ 9

Michigan's Legal Framework--- 11

Erosion and Sedimentation Control Act---------------------- 12

Subdivision Control Act------------------------------------ 12

Local Government Zoning Enabling Legislation-------------- 13

Michigan Drain Code-- 13

Wetland Protection Act------------------------------------- 14

Dam Construction Approval Act----------------------------- 14

Inland Lakes and Streams Act------------------------------- 14

Michigan Environmental Protection Act--------------------- 15

5

CHAPTER II: SUMMARY AND ANALYSIS OF LOCAL GOVERNMENT CASE STUDIES-------- 17

- Selection of Case Study Locations-------------------------- 19
- Effective Local Government Stormwater Management Programs---- 20
- Criteria for Effective Local Government Programs------------ 21
  - Recommended Stormwater Management Planning Activities----- 21
  - Recommended Stormwater Management Regulatory Activities--- 24
  - Recommended Stormwater Facility Design, Construction, and Maintenance Activities------------------------------------ 27
- Description and Analysis of Case Studies-------------------- 29
  - Rationale for Stormwater Management---------------------- 29
  - Description of Planning Programs------------------------ 30
  - Analysis of Planning Programs---------------------------- 32
  - Description of Regulatory Programs---------------------- 33
  - Analysis of Regulatory Programs------------------------- 35
  - Description of Facility Construction and Maintenance Programs-- 36
  - Analysis of Facility Construction and Maintenance Programs-- 38
- Implications of Case Studies for Other Southeast Michigan Communities-- 39

APPENDIX A: STORMWATER MANAGEMENT CASE STUDIES------------------------- 41

- City of Farmington Hills------------------------------------ 43
- Oakland Township--- 53
- Pittsfield Township-- 63
- City of Sterling Heights------------------------------------ 71
- City of Troy--- 81
- FOOTNOTES--- 89

APPENDIX B: BIBLIOGRAPHY--- 91

ACKNOWLEDGEMENTS--- 95

LIST OF TABLES

Page

Table 1 Stormwater Management Planning Program Components--------------- 31

Table 2 Stormwater Management Regulations for Development Plan Reviews-- 34

Table 3 Construction, Operation, and Maintenance Programs for Stormwater Retention Facilities-- 37

LIST OF FIGURES

Page

Figure 1 Stormwater Management Case Study Locations in Southeast Michigan-- 4

Figure 2 Interrelationship of Stormwater Management to other Governmental Program Areas---------------------------------- 10

CHAPTER I: INTRODUCTION TO LOCAL GOVERNMENT

CASE STUDIES

CHAPTER I: INTRODUCTION TO LOCAL GOVERNMENT CASE STUDIES

SCOPE OF THE REPORT

In the past four to five years, a number of townships, villages, and cities in Southeast Michigan have recognized the importance of local programs for stormwater management. Downstream flooding, limited public finances, and increasing awareness of the environmental effects of urbanization have led to local management programs.

Within the next several years, it is expected that the trend toward local government stormwater management programs will continue. This report is intended to be a sourcebook of stormwater management program approaches for use by local governments developing or revising their approach to stormwater management.

The focus of this report is on five case studies of local government stormwater management programs in Southeast Michigan. Stormwater management programs from the following communities are documented (see Figure 1):

- City of Farmington Hills (Oakland County)
- Oakland Township (Oakland County)
- Pittsfield Township (Washtenaw County)
- City of Sterling Heights (Macomb County)
- City of Troy (Oakland County)

The case study communities were selected because they represent a variety of geographic and topographic conditions. In each case, local officials have recognized the need to deal with stormwater problems and have made stormwater policies and regulations a community asset.

The standards and program approaches used by each case study community vary, and should not be automatically transferred to other communities without careful local review and consideration. Nevertheless, the experiences of these communities with stormwater management represents useful illustrations and examples for consideration by other local governments in Southeast Michigan.

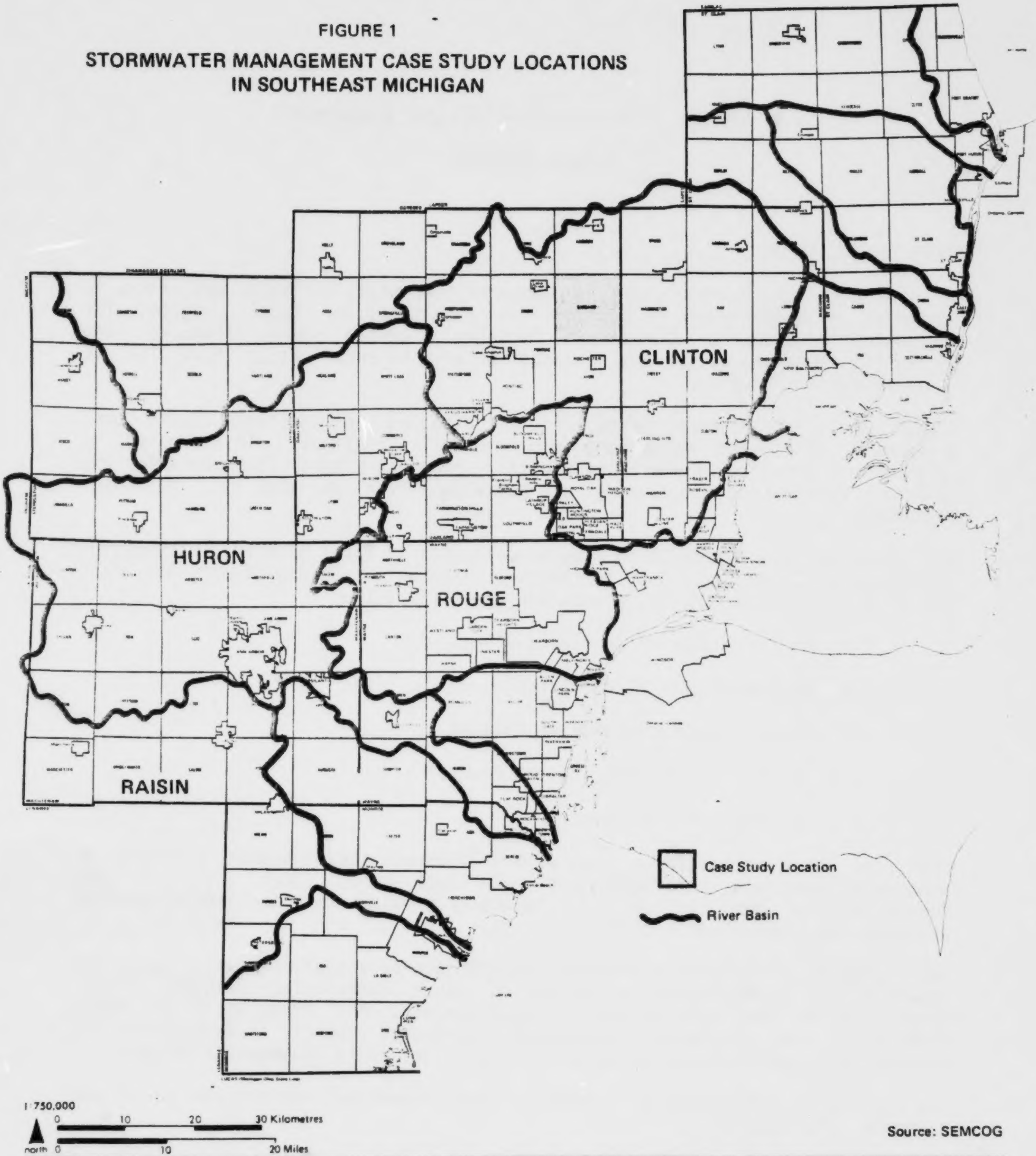
The following definitions of "retention" and "detention" reflect the use of the terms in this report:

Detention: Temporary storage of stormwater with gradual release at a predetermined rate to surface waters. Detention basins may be "wet"

Preceding page blank

FIGURE 1

STORMWATER MANAGEMENT CASE STUDY LOCATIONS IN SOUTHEAST MICHIGAN


CLINTON
HURON
ROUGE
RAISIN
Case Study Location
River Basin
1:750,000
0
10
20
30 Kilometres
north
0
10
20 Miles

Source: SEMCOG

SOUTHEAST MICHIGAN COUNCIL OF GOVERNMENTS basins (outlets are raised above a certain water level) or "dry" basins.

Retention: Holding of stormwater for a substantial period of time followed by release through evaporation, plant transpiration, or infiltration into the soil. Retention basins may also be "wet" or "dry" basins.

Because of the confusion over these two terms, the terms "retention/detention" or simply "retention" are frequently used in this report to refer to both types of basins. Most basins in Southeast Michigan are actually detention basins.

This report is organized into three parts, as follows:

A. Chapter I: Introduction to Local Government Case Studies -

- Stormwater management program goals, definition of comprehensive stormwater management, and review of Michigan laws affecting local stormwater management programs.

B. Chapter II: Summary and Analysis of Local Government Case Studies -

- Criteria for effective local government stormwater management programs, comparison of case studies, and implications of the case studies for other local government stormwater management programs.

C. Appendix A: Stormwater Management Case Studies -

- Descriptions of the stormwater management philosophy, programs, and innovative features of five local governments in Southeast Michigan.

In describing the experience of the five selected local governments, an effort has been made to define the content of the stormwater management programs as well as the program origins and philosophy. Local governments developing their own programs may wish to contact the case study communities for further information.

STORMWATER QUALITY MANAGEMENT

Stormwater management for flood control purposes has been the predominant focus of most local government stormwater management programs in Southeast Michigan. As reflected by the case studies in this report, however, stormwater can be managed for multiple purposes, including water quality control.

The importance of managing stormwater for quality control purposes has been highlighted in recent studies. Stormwater runoff from developed areas carries sediment, nutrients, heavy metals, fish and wildlife, and affects the community's use of water resources. When buildings are constructed and soils covered with pavement, the quantity of stormwater runoff increases and pollutants on the surface of the land are rapidly carried to surface waters. Placement of impervious surfaces on 20 percent of a development site can result in a 100 percent increase in the volume of stormwater runoff.

Data compiled by SEMCOG in the Rouge River watershed revealed that urban stormwater contributes 42 percent of all suspended solids to the Rouge River. Sediment and suspended solids smother fish and small organisms, reduce the ability of stream channels to carry floodwaters, and can destroy fishing and swimming activities.

Research completed by the Washtenaw County Drain Commissioner reflects the magnitude of the urban stormwater pollution problem. Runoff during a 24-hour period after a spring snowmelt was found to contribute a suspended pollutant load to the Huron River equivalent to the treated discharges from the Ann Arbor wastewater treatment plant over a 68-day period.

The quality of stormwater should be managed by local governments for several reasons:

1. Stormwater contributes significant pollutants to the region's lakes, streams, and rivers;

2. Stormwater quality control practices (including retention/detention basin construction and the use of natural areas for stormwater infiltration) can avoid costly storm drain projects in some cases; and

3. Management of stormwater for water quality purposes can help to avoid development delays and costly law suits under the Michigan Environmental Protection Act (Act 127, P.A. of 1970).

Stormwater retention and detention methodologies that can improve water quality are highlighted below.

1. Stormwater retention and detention basin construction -

   Retention and detention basins (often constructed for flood control purposes) hold stormwaters and allow some sediment to settle and/or filter from the stormwater before it is discharged to surface or groundwaters. Heavy metals, nutrients, and other pollutants often adhere to sediment particles. Large basins which hold stormwater for a long period of time are particularly useful for stormwater pollutant management.

2. Stormwater detention using natural depression lowlands and wetlands -

   Natural areas (especially wetlands) absorb stormwater, slow the flows, and allow some nutrient removal to occur. Stormwater carrying heavy sediment loads, of course, can harm wetlands which have important biological functions. However, when wetlands and depressions are used in their natural capacity of storing stormwater, water quality can be enhanced and downstream flooding avoided. As a supplement to basins and stormwater holding areas, grassed swales can be used to direct the flows of stormwater runoff. Grassed swales also promote natural infiltration for decomposition of some pollutants.

Retention basin research presently being conducted by the Southeast Michigan Council of Governments and the Oakland County Drain Commissioner and wetlands research being conducted by the Washtenaw County Drain Commissioner will soon provide technical information and guidelines on stormwater quality management.

A state or federal law which requires each local government to adopt stormwater detention policies does not exist. However, unless local governments develop effective programs, it is only a matter of time before a state or federal regulatory program intervenes. In addition, local governments should consider the potential for citizen law suits brought in response to the Michigan Environmental Protection Act (Act 127, P.A. of 1970). It is expected that local government officials concerned about the future of their community will wish to provide environmental quality protection whenever practical.

STORMWATER MANAGEMENT PROGRAM TRENDS

Stormwater management concerns have been addressed by local governments in Southeast Michigan in a variety of ways. Some local governments have built expensive storm sewer facilities for conveying runoff away from their community. Unfortunately, this approach to stormwater management often intensifies problems by transferring the problem downstream. Other local governments have ignored the problem and have done nothing. A growing number of local communities, however, are viewing stormwater as a resource rather than a nuisance, with a potential for providing benefits to the community.

The "new" view of stormwater management is emerging from several forces:

1. Local governments have severely restricted finances, especially for public works projects. The Headlee amendment has effectively eliminated general obligation bonds as a tool available to local governments for financing public works projects. Alternatives to costly storm sewer construction, therefore, are being sought.

2. As a result of court cases and inter-governmental communication, local governments are increasingly aware of the downstream flooding issue. Many local governments are also aware of flooding problems within their communities which have resulted from inefficient management practices.

3. The inter-relationship of stormwater with other water resource systems is becoming apparent. In order to protect inland lakes as well as groundwater supplies, communities are encouraging the on-site detention and infiltration of stormwater. On-site detention with no outlet to a receiving stream can help recharge groundwater and generally enhance water resources.

4. The general water quality benefits of certain types of stormwater management programs are beginning to be recognized. Several local governments in Southeast Michigan have combined stormwater management with wetlands and water quality protection efforts.

5. Visible examples of attractive and effective retention and detention basins are scattered throughout Southeast Michigan. Local governments are recognizing the multiple-use potential of stormwater facilities.

Local government stormwater management policies are in the state of flux. A recent survey of townships and cities in Oakland County revealed that twenty-eight out of thirty-five local agencies surveyed require on-site retention or detention of stormwater for new developments. Although on-site retention/detention is a less prevalent policy in other counties, there appears to be a trend toward retention/detention requirements. Within the next three years, it is expected that many additional local governments in developing areas will be considering and adopting stormwater management policies for water quantity and water quality control purposes.

Local governments which want to control stormwater runoff and maximize community benefits often focus attention on three types of regulatory activities:

1. On-site retention or detention of stormwater, generally achieved through construction of a basin or use of a parking lot. Retention facilities provide for permanent standing water in the facility; detention facilities detain stormwater for a short period of time before releasing it at a slow rate to a lake, stream, or lowland area. Some basins combine the retention and detention functions -- they maintain a regular water level but discharge stormwater at controlled rates during times of overflow.

2. Regulation of site grading during construction in order to minimize erosion and sedimentation. Large sites are regulated by local and county agencies in accordance with the Michigan Erosion and Sedimentation Control Act (Act 347, P.A. of 1972). Many local governments which have active stormwater management programs supplement erosion permit requirements by reviewing grading plans for all sites, regardless of size, for erosion control as well as drainage purposes.

3. Protection of wetlands, lowlands, floodplains, and other natural areas which provide stormwater storage values. Several local governments encourage or require the use of natural areas for stormwater retention, sometimes as a substitute for a man-made basin. Many local governments have adopted open space preservation policies and regulations which provide stormwater storage benefits, as well as recreational and scenic amenities.

The trend toward stormwater resource management is illustrated by the case studies documented in this report.

COMPREHENSIVE STORMWATER MANAGEMENT

Stormwater management involves the array of policies, activities, and programs which government agencies use to ensure that stormwater runoff benefits the community, while avoiding water quality and flooding problems.

Public management concerns about stormwater commence when rain falls to the earth. First, stormwater must be collected for storage and/or discharge purposes. If on-site retention or detention is needed, appropriate facilities must be provided. The discharge of stormwater to surface or groundwaters must be controlled so that potential problems are avoided. Man-made structures such as retention/detention basins as well as natural floodplains, wetlands, and lowlands may be part of the physical system for controlling stormwater runoff. Storm drain pipes or restructured drainageways may be required to safely control the flow of stormwater from the community.

The definition of comprehensive stormwater management can be approached in two ways: (1) through the definition of subject matter to be the focus of stormwater concerns; and (2) through a review of the types of government programs to be carried out. Each of these aspects is highlighted below.

Functional Inter-Relationships with Stormwater Management

Stormwater management is an activity of government agencies which is inter-related with other functional program areas. A comprehensive stormwater management program is one which includes or considers aspects of all government activities affecting stormwater. The circles in Figure 2 represent land and water management programs which are inter-related with stormwater management. The two sets of circles are also related to each other.

Although the central purpose of stormwater management is different from floodplain management, wetlands management, and the other program areas diagrammed, the principles, techniques, and practices frequently overlap. As stormwater management evolves to a multiple-purpose activity of local governments, the inter-relationships will become more extensive and program activities will merge together. The recognition of potential relationships reduces administrative costs and helps communities to implement goals and programs. For example, the recognition that development of a waterfront park can be used to preserve wetlands and manage urban stormwater makes it possible for the local government to meet several objectives at minimal cost.

Stormwater Management Program Components

Comprehensive stormwater management programs of local governments should include four types of program activities:

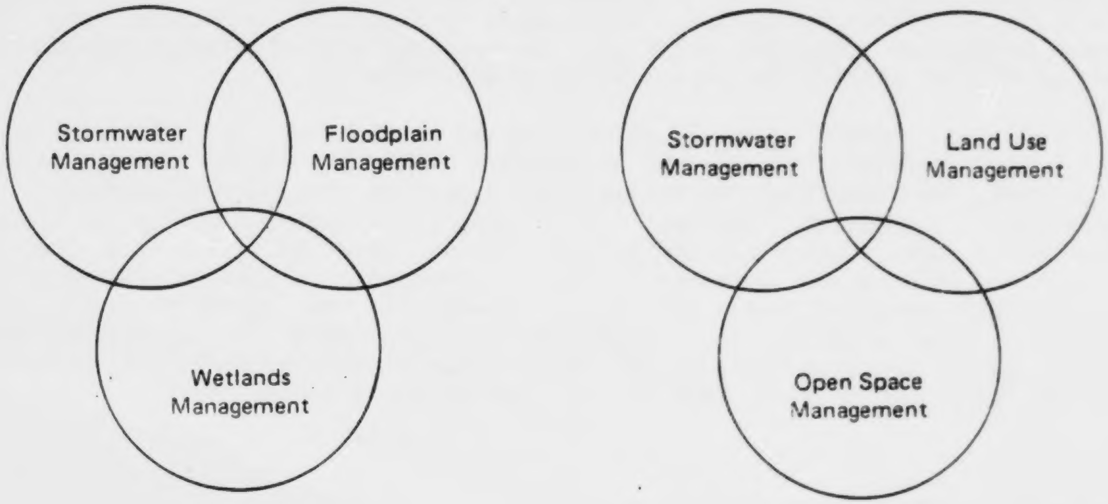
- Planning Programs: Planning includes activities directed to development of policies, plans, and regulations in order to solve or avoid stormwater problems. Data collection, plan preparation, project impact assessment, and intergovernmental coordination are examples of stormwater planning activities. The development of regulatory and operations programs before they are implemented is also considered to be part of stormwater planning.

- Regulatory Programs:: Stormwater regulatory programs focus on the administration of ordinances and regulations which control urban development. Typically, regulatory programs involve the issuance of permits, approval of development plans, on-site inspections, and enforcement of the regulations. In Southeast Michigan, stormwater retention/detention regulations have often been included in engineering design standards adopted as policy by the local governing body. Some communities incorporate stormwater regulations into zoning and subdivision ordinances as well.

- Construction, Operation, and Maintenance Programs: Stormwater facilities such as retention/detention basins and storm drains must be properly

FIGURE 2

INTERRELATIONSHIP OF STORMWATER MANAGEMENT TO OTHER GOVERNMENTAL PROGRAM AREAS


Stormwater Management
Floodplain Management
Wetlands Management
Stormwater Management
Land Use Management
Open Space Management

The circles above represent land and water management programs which are interrelated with stormwater management. The two sets of circles are also related to each other.

constructed, operated, and maintained in order to provide continuing flood control and water quality control benefits. In some cases, local governments may undertake the acquisition of land and construction of large-scale retention/detention basins to serve the community. In other cases, local governments may assume basin inspection and maintenance responsibilities. One approach which may be taken to maintenance is to enter into maintenance agreements with private landowners to assure proper facility functioning. Maintenance activities for retention/detention basins typically include "housekeeping" maintenance such as grass cutting and removal of trash, as well as cleaning of filters and the removal of sediment from basins.

- Financing Programs: Stormwater management programs and requirements administered by local governments must receive financial support. Methods for financing necessary planning, regulatory, and construction and maintenance activities are integral to stormwater management. Whenever possible, stormwater financing programs should be based on the principle that landowners contributing to or benefiting from stormwater management should pay for the cost of the service (similar to sanitary sewerage and water supply services).

When packaged together, planning, regulation, construction, operation, and maintenance and finance activities for stormwater control comprise the local government's stormwater management program.

MICHIGAN'S LEGAL FRAMEWORK

Michigan laws provide for the involvement of state, county, and local agencies in stormwater management. Without strong local government programs which are comprehensive in scope, however, stormwater management can become fragmented with many opportunities for policy and program coordination overlooked.

The most significant Michigan laws which affect stormwater facilities and management practices are referenced in this section. These laws include the following:

- Erosion and Sedimentation Control Act (Act 347, P.A. of 1972);
- Subdivision Control Act (Act 288, P.A. of 1967);
- City or Village Zoning Act (Act 207, P.A. of 1921, as amended);
- Township Rural Zoning Act (Act 184, P.A. of 1943, as amended);
- Michigan Drain Code (Act 40, P.A. of 1956, as amended);
- Wetlands Protection Act (Act 203, P.A. of 1979);
- Dam Construction Approval Act (Act 184, P.A. of 1963, as amended);
- Inland Lakes and Streams Act (Act 346, P.A. of 1972); and
- Michigan Environmental Protection Act (Act 127, P.A. of 1970).

In addition to these laws, the Michigan Department of Natural Resources requires permits for drainage from certain pipes or parking lots when there are significant water quality problems directly linked to particular businesses.

Each of these laws and its relationship to local government stormwater management is briefly highlighted in the sections which follow. More extensive descriptions of state and county programs developed in response to these laws is contained in the report titled A Description and Assessment of Stormwater Management Programs in Oakland County, prepared by the Southeast Michigan Council of Governments.

Erosion and Sedimentation Control Act

The Michigan Erosion and Sedimentation Control Act (Act 347, P.A. of 1972) establishes a uniform requirement for the issuance of erosion and sedimentation control permits. A permit is required for earth changes on developments one acre or more in size as well as developments located within 500 feet of a river or stream. The intent of the Act is to require certain land management practices (such as stormwater diversion structures, siltation basins, and straw bales) which reduce accelerated soil erosion and help protect water quality.

Cities and charter townships may elect to administer and enforce the erosion and sedimentation permit program. Counties are responsible for this regulatory program within general law townships as well as local jurisdictions which choose not to administer their own permits.

Although the focus of the permit program is on the reduction of accelerated soil erosion and sedimentation during site development and construction, the program rules include requirements for limiting water flows from temporary or permanent retention facilities to non-erosive velocities. The Michigan Department of Natural Resources monitors implementation of the Act.

Subdivision Control Act

The Subdivision Control Act (Act 288, P.A. of 1967) is of central importance for stormwater management by local governments. The law requires the drain commissioner in each county to review proposed subdivision plats "to ensure that adequate stormwater facilities are designed." A definition of "adequate stormwater facilities" is not contained in the Act. As defined by the Subdivision Control Act, subdivisions are an act of division of land which creates:

- Five or more parcels, each of which is ten acres or less in area; or
- Five or more parcels, each of which is ten acres or less in area created by the successive division of land within a ten year period.

The law does not specify the requirements or standards for the stormwater facility review. Several drain commissioners in Southeast Michigan use the Subdivision Control Act as a legal basis for requiring on-site retention/detention of stormwater and discharge at an agricultural rate in cases where downstream flooding would result. The Subdivision Control Act also authorizes county drain commissioners to require the establishment of a county drainage district when needed to ensure adequate maintenance of stormwater facilities.

The Subdivision Control Act allows townships, villages, and cities to review and approve subdivision plats in accordance with adopted local subdivision control ordinances. Although a stormwater management or drainage review is not specifically required, many local governments exercise their legal authority and review subdivision plats for stormwater management purposes. The stormwater management review typically is completed as part of a comprehensive subdivision plat review. Requirements and specifications for stormwater management such as on-site retention and detention vary among communities.

Local Government Zoning Enabling Legislation

The City or Village Zoning Act (Act 207, P.A. of 1921, as amended) and the Township Rural Zoning Act (Act 184, P.A. of 1943, as amended) provide broad authority to local governments to adopt zoning ordinances to regulate land uses within their jurisdictions. Local governments may require landowners to submit a site plan as part of a rezoning approval. Site plan decisions must be based upon standards written in the zoning ordinance; if a site plan meets all standards and applicable laws, it must be approved.

Local government zoning ordinances, through site plan review requirements, provide a legal basis for a stormwater management review of development proposals which are not subdivision plats. Local governments often apply the same stormwater management standards and requirements to both subdivision plats and site plans.

Michigan Drain Code

The Michigan Drain Code (Act 40, P.A. of 1956) provides drain commissioners in each county with legal authority to design and construct storm drains at the request of local governments or landowners. By definition, a "drain" may be a branch or portion of a stream or river, a ditch or pipe, a storm sewer, a dike or barrier, or any other device constructed for drainage purposes. County drains may be natural or man-made areas or facilities. Retention/detention basins constructed or maintained by drain commissioners, therefore, may officially be termed "county drains." Wetlands may also be acquired by drain commissioners as part of a drain project and used for stormwater retention/detention purposes.

Permits are typically required before a landowner may discharge into an established county drain. In effect, control over county drains extends the regulatory authority of drain commissioners to include many properties which are not subdivision plats.

Using authority of the Michigan Drain Code, drain commissioners can carry out retention/detention basin maintenance programs. When maintenance of retention and detention basins is provided, landowners benefiting from the facility are typically included in a local assessment district and charged for the cost of maintenance.

Wetlands Protection Act

The Goemaere-Anderson Wetlands Protection Act (Act 203, P.A. of 1979) prohibits the alteration of certain wetlands without a permit from the Michigan Department of Natural Resources. The state law specifically authorizes local governments to adopt wetlands protection ordinances with requirements which are more stringent than the state requirements.

Since wetlands serve important stormwater detention and filtration functions, the protection of wetlands is directly related to stormwater management. The discharge of stormwater into wetlands via a pipe or canal is an activity subject to permit requirements.

Dam Construction Approval Act

The Dam Construction Approval Act (Act 184, P.A. of 1963) requires the issuance of permits for the construction of dams which impound more than five acres of land or which have a hydrostatic head of five or more feet of water. Many permanent retention basins are subject to requirements of this law. Permits are issued by the Michigan Department of Natural Resources. The focus of the permit requirements is public safety and the prevention of hazardous conditions. Stormwater volume or conveyance methods are not reviewed when permits are issued.

Inland Lakes and Streams Act

In accordance with the Inland Lakes and Streams Act (Act 346, P.A. of 1972, as amended), the Michigan Department of Natural Resources requires the issuance of a permit prior to the creation or alteration of an inland lake or stream, or to build a structure in a lake or waterway. Permanent impoundments such as retention basins are often subject to permit requirements.

In reviewing permit applications, the Department of Natural Resources considers the effect of the proposed project upon the inland lake or stream, connecting waterways, and the uses of the waters. A permit will not be issued if significant water quality problems will result from the discharge. However, the Department of Natural Resources does not have authority to require the installation of a retention or detention facility if one has not been proposed as part of the project.

Michigan Environmental Protection Act

The Michigan Environmental Protection Act (Act 127, P.A. of 1970) is of central importance for the management of stormwater for water quality purposes. This law places a duty on all individuals and organizations to prevent or minimize environmental degradation which is caused or likely to be caused by their activities. Although the Michigan Environmental Protection Act does not establish new state, county or local programs or require the issuance of permits, it potentially can affect all stormwater management activities by governmental agencies. This law gives citizens standing to sue developers and government agencies which have not provided for adequate environmental protection in project plans.

CHAPTER II: SUMMARY AND ANALYSIS OF LOCAL GOVERNMENT CASE STUDIES

Preceding page blank

CHAPTER II: SUMMARY AND ANALYSIS
OF LOCAL GOVERNMENT CASE STUDIES

SELECTION OF CASE STUDY LOCATIONS

On-site stormwater retention/detention for new developments is not a new practice for a number of Southeast Michigan communities. An estimated 40 to 50 local governments in Southeast Michigan require on-site retention or detention as a standard practice. Several rapidly developing communities have administered retention requirements for ten years or more.

Nevertheless, there are relatively few examples in Southeast Michigan of comprehensive stormwater management programs. Many communities have established stormwater retention requirements out of necessity -- to avoid flooding, to avoid court cases and related damages, and to avoid expensive storm drain construction projects. The view that stormwater management requires planning, inspection and maintenance, and even land acquisition and construction by the local government, is just emerging.

The case studies documented in this report are examples of townships and cities in Southeast Michigan which recognize that stormwater management activities must extend beyond on-site retention/detention regulations. The particular approaches and programs as well as rationales for stormwater management vary among the case examples. Therefore, the case studies can be viewed as a "shopping list" of approaches which may be useful in other communities. Each local government should, of course, carefully consider stormwater management program options and develop a program best suited to the individual community's needs.

The case study communities were selected because of their experience with stormwater management problems. It is anticipated that the history of the community's efforts as well as their present programs and standards will be useful source materials for other communities. The case study communities are located in different physical settings:

- City of Farmington Hills (Oakland County) - A rapidly developing suburban community dominated by rolling hills and wooded lots (Rouge River watershed).
- Oakland Township (Oakland County) - A rural township with agricultural lands and scattered wetlands and woodlands (Clinton River watershed).
- Pittsfield Township (Washtenaw County) - A township characterized by rapid urbanization in areas adjacent to the City of Ann Arbor but with substantial remaining agricultural and rural lands. The terrain in Pittsfield Township is flat with scattered lowland and poorly drained areas (Huron River, Stony Creek, and Saline River watersheds).

Preceding page blank

- City of Sterling Heights (Macomb County) - A rapidly developing suburban community characterized by flat, low lying topography (Clinton River watershed).

- City of Troy (Oakland County) - A suburban community characterized by rapid growth over the past decade. Although most of the terrain is flat, the northwest quadrant has gently rolling lands with scattered woodlots (Clinton River and Rouge River watersheds).

The regional locations of the case study communities are shown on Figure 1. The types of stormwater management programs which have evolved in each community reflect their physical settings, potential stormwater problems, and perceptions of local officials.

This chapter compares and contrasts the case study stormwater management programs with each other. Major findings which are of significance to other Southeast Michigan communities are highlighted. Components of effective local government stormwater management programs are presented as a basis for the case study analysis.

Interested readers are encouraged to read the case study reports contained in Appendix A for further information. Local officials, staff, and consultants who can provide additional information are listed at the end of each case study.

EFFECTIVE LOCAL GOVERNMENT STORMWATER MANAGEMENT PROGRAMS

What is an effective local government stormwater management program? How can the case studies documented here be evaluated? The purpose of this section is to lay a basis for the analysis of the case studies. The elements of effective local government programs, as outlined here, comprise criteria for evaluating the case studies.

The information in this section is based on several sources of information:

1. Recommendations from the Urban Nonpoint Advisory Committee of the Southeast Michigan Council of Governments (SEMCOG);

2. A selective review of stormwater management programs in other states which have focused on stormwater retention and environmental management; and

3. The experience of the case study communities with stormwater management.

The detailed scope of any local government stormwater management program should, of course, refelct the particular problems and needs of that community.

CRITERIA FOR EFFECTIVE LOCAL GOVERNMENT PROGRAMS

Local government stormwater management programs should be directed toward two interrelated and complementary goals:

- The enhancement of stormwater quality; and
- The control of stormwater flows in order to avoid flooding and maintain in-stream water levels.

In the past, most local governments have directed stormwater management programs toward a single goal -- the control of flooding. Managing stormwater quality does not need to involve chemical treatment of stormwater or other expensive measures. On-site stormwater retention through basins and the use of natural areas and wetlands can provide important water quality benefits. With little additional cost and with many additional benefits, stormwater can be managed for both quantity and quality control purposes.

Within the goals of stormwater quality and flooding control, local government stormwater management programs can incorporate multiple objectives. For example, one local government may direct its stormwater management efforts toward flood prevention and open space protection. Another local government may direct stormwater management efforts toward flood prevention, groundwater enhancement, and wetlands protection. Although the particular objectives vary, in both cases the local governments recognize the potential for multiple purposes and benefits from stormwater management.

Three types of stormwater management program activities should be carried out through local government programs:

- Stormwater management planning, and intergovernmental coordination;
- Stormwater management regulations controlling new developments; and
- Stormwater facility construction, inspection, and/or maintenance.

Each program area, of course, should include specific program elements or activities which reflect the existing stormwater problems and future stormwater management opportunities for that particular community. Financing options should be considered as part of planning and program development.

Recommended Stormwater Management Planning Activities

Planning is the process of identifying present and potential stormwater problems as well as opportunities for addressing the problems. The planning process consists of several distinct steps:

- Development of program objectives;
- Data collection and analysis;

- Identification of alternative strategies;

- Evaluation of alternative strategies and selection of the most feasible approach;

- Implementation of recommended approach through the establishment of appropriate programs; and

- On-going program monitoring.

Planning for stormwater management focuses on the development of policies and programs for carrying out the policies. Of necessity, it should include communication and coordination with other local governments within the watershed.

Public participation in local stormwater management planning programs is also important. Stormwater management policies and programs often affect the appearance, resources, development, and finances of the community. Members of the public have the right to be informed of program options and to advise local elected officials of their preferences.

Examples of stormwater management planning activities which are possible components of local programs are listed below. Perhaps more than any other category of stormwater management program activities, planning activities will vary with the particular needs of a local government. Some of the activities outlined can be carried out by existing government staff members at a very low cost. Other activities require special funding commitments.

Development of Program Objectives:

1. Define stormwater management issues, problems, and concerns, including stormwater problems and potential future problems.

2. Identify potential program objectives. Will the proposed stormwater management program address recreational use of stormwater facilities? Protection of open space areas for multiple purposes? Groundwater or wetlands protection?

Data Collection and Analysis:

3. Organize a data base which displays the natural and man-made system for stormwater conveyance and storage. Natural features identified should include wetlands and lowlands, stream channels, floodplains, drainage basins, and areas of steep slopes. Manmade features include storm drains and retention/detention facilities. If possible, data should be organized and mapped at a detailed scale and related to property boundaries for use in reviewing development plans.

4. Assess the present stormwater conveyance and storage system. What problems are presently created? If future development occurs, what problems will occur?

5. Review the natural hydrologic system in the community, including surface and groundwater flows. If stormwater is retained on-site, what will

happen to surface and groundwaters? Is there a need for water conservation? Can stormwater management and environmental protection needs be combined?

6. Identify storm flows from upstream communities and their impact on the community. Identify stormwater volumes discharged from the community and potential downstream effects. Identify intergovernmental issues which should be addressed during the planning process.

7. Examine existing policies, regulations and programs which affect stormwater. What is the effect of existing regulations on stormwater runoff? What are the views of developers regarding the regulations?

8. Project future population and land use trends to identify future volumes of stormwater runoff. (Projections should be made with the assumption of no stormwater management program or no expansion of existing programs.)

Identification of Alternative Strategies:

9. Identify alternative approaches to managing stormwater for quantity and quality control purposes.

    - Is a regulatory program for controlling runoff in developing areas needed?

    - Does the community wish to allocate certain allowable runoff volumes to different areas of the community?

    - Are public acquisition programs needed to provide areawide or community stormwater retention/detention areas?

    - Are physical structures such as storm drain pipes needed for stormwater conveyance?

Evaluation of Alternative Strategies and Selection of the Most Feasible Approach:

10. Evaluate alternative management strategies in terms of costs, benefits, and political feasibility. The short- and long-range effects of stormwater management policies on energy, environment, inflation, and resources should be identified.

11. Evaluate the impacts of stormwater strategies on other public programs, such as highways, utilities, and recreation programs. Are effects beneficial? Can alternative stormwater strategies be further expanded or modified to encompass objectives of several programs?

12. Review alternative strategies with citizens and decisionmakers. Representatives from developers and builders organizations should participate in the review. Public information concerning the costs and benefits of stormwater management should accompany the review of alternatives.

13. Select and adopt the most appropriate stormwater management strategy and related regulatiions and programs.

Implementation of Recommended Approach:

14. Identify program management responsibilities and develop a schedule for detailed program planning.

15. Prepare a manual which describes the stormwater management program, including regulations and review procedures. The manual should include all development regulations which affect landowners and developers, and should assist the landowner in submitting development plans for review and approval. In effect, a manual creates a "no surprise" situation by providing clear, explanatory materials.

16. Prepare and distribute public information and education materials concerning the stormwater management program in order to assure public understanding and to facilitate public support. Community meetings and workshops may be useful at several points in the planning process.

On-Going Program Monitoring:

17. On a periodic basis, review stormwater management policies, programs, and regulations to identify effects. Review approaches to strengthening programs, as needed.

Technical assistance from watershed councils, county drain commissioners, the Michigan Department of Natural Resources, and the Southeast Michigan Council of Governments may be useful in local government stormwater management planning. Technical assistance needs must be identified by the local jurisdiction, however, and organized into a logical planning and program development effort.

Recommended Stormwater Management Regulatory Activities

The regulation of new development to assure proper management of stormwater runoff is of central importance for local government stormwater management programs. When runoff is properly managed in new developments, the need for costly remedial facilities in the future can be avoided. The costs of stormwater facilities in new developments are usually paid by the developers. The costs of government regulatory programs can be charged to landowners when development plans are submitted.

In all cases, regulations should be formally adopted by the local governing board. Unless regulations are adopted, there may be confusion concerning the scope of local government requirements. Adopted standards provide clear direction to technical staff and consultants, assure uniformity of requirements, and provide a legal framework if law suits should arise. Variance procedures to take into account hardship situations may also be useful.

In developing the stormwater regulatory program, the local community has several options:

1. To require on-site retention/detention of stormwater for all new developments;

2. To require on-site retention/detention of stormwater only in cases where the receiving waterway is small;

3. To require the developer to pay a fee or dedicate land as part of a community retention/detention facility; or

4. To allow discharge of runoff directly into surface water bodies.

A combination of these policies is often useful. For example, through planning, several community or areawide stormwater retention/detention areas could be identified. Only developments draining into the areas would be subject to community retention/detention facility regulations. In all other areas of the community on-site retention or detention of stormwater would be needed.

Although on-site retention and detention of stormwater often provides benefits for water quantity and quality control, there are several exceptions. If a community is at the downstream end of a watershed, for example, retention may actually increase flood peaks. Increased peaks occur if the discharge of stormwater from the community coincides with the arrival of upstream flood waters. When developing retention policies, downstream communities should carefully consider upstream flow rates, existing stream capacities, and water quality benefits related to stormwater retention. The design and location of retention and detention basins also affects their benefits. Careful engineering design and review is needed to assure proper functioning and maximum community benefits.

In certain instances, retention or detention of stormwater on the site may not be needed for flood control purposes. For example, if the site is adjacent to a large lake or major river, the contribution of stormwater from the development may not pose an immediate flooding problem. However, two important questions should be asked before retention/detention requirements are waived:

- If all of the developable lands in the subwatershed area become urban, will the river or lake be able to handle the stormwater runoff?

- Will stormwater runoff create water quality problems?

Recognizing the multiple benefits from on-site retention/detention and the desirability of having uniform requirements for all developments, some communities always require on-site retention or detention of stormwater, regardless of the size of the receiving stream or lake.

The particular type of facility used to provide on-site stormwater retention or detention will vary among developments and among communities. Some local governments prefer dry detention basins with shallow sides because they are low in maintenance and can be used as open recreation spaces during dry weather. Other communities prefer attractively designed permanent retention basins which function as lakes or wildlife ponds. Several communities in Southeast Michigan intentionally use wetlands and lowland areas as stormwater retention areas. Dished parking lots, grassed swales, or shallow depressions are often used for detention on sites smaller than an acre.

Historically, detention basins have been disliked by citizens and officials because of their nuisance characteristics. Basins have been viewed as temporary, pending the construction of larger storm drains or channels. Reflecting their temporary nature, little attention has been placed on the appearance of basins. Excavated pits with fences have been constructed to hold stormwater. As a result of changing philosophies, technical information, and financial restrictions, many retention/detention facilities are now considered to be permanent. Engineers, planners, and planning commissions are encouraging developers to integrate retention/detention facilities into the development with attention to appearance and recreational use potential.

The following guidelines are recommended for local government stormwater regulatory programs:

1. Through the review and approval of development plans, ensure that stormwater runoff is controlled on the site with appropriate retention/detention facilities and areas. Stormwater discharged from the site should not create flooding, low water levels, or water pollution problems.

2. Developments where stormwater runoff can be stored in communtiy or areawide retention/detention areas, require a special retention fee or dedication of land in lieu of on-site retention or detention facilities.

3. Whenever soils permit, use natural depressions, swales, wetlands, and lowlands to retain stormwater and provide a slow release to groundwaters. The use of natural drainage areas such as these can save facility construction costs while providing attractive areas within the development. Stormwater retention in natural areas often has added water quality benefits.

4. Restrict stormwater runoff discharges to a pre-development or agricultural rate. (This rate is often estimated to be 0.1 - 0.2 cfs/acre).

5. Manage stormwater runoff from minor storms (10-year frequency storms) and major storms (100-year frequency storms). Both routing and storage should be considered. Stormwater routing and storage for minor storms can usually be provided in a way which is attractive and avoids local flooding. Stormwater runoff areas for major storms are often overflow areas from the minor storm.

6. Require stormwater easements for major flow routes and retention areas. Easements should protect stormwater areas from obstructions and provide entry for maintenance purposes.

7. Through the review of development plans, minimize the amount of paved surface on the site. Cluster development options such as "planned unit developments" and "planned residential developments" can reduce impervious surface and provide open spaces which have stormwater retention benefits.

8. When natural areas such as depressions and wetlands provide significant retention benefits, the required capacity of retention/detention basins or dished parking areas should be reduced by a corresponding amount.

9. Require the developer to indicate the velocity and volume of stormwaters entering and leaving the site for use in planning stormwater facilities.

10. Control erosion, sedimentation, and stormwater runoff during site development and construction. In all cases, development plans and grading plans should be reviewed to minimize the area of exposed soils and erosion potential. Erosion and sedimentation permits (as required by state law for properties one acre or more in size or within 500 feet of a river or lake) should specify the measures to be used to control erosion and sedimentation.

11. Encourage developers and engineers to provide stormwater retention/detention facilities which have low maintenance costs.

12. Coordinate local government stormwater management regulations with state permit requirements. For example, large retention basins may require a Dam Construction Approval Permit or Inland Lakes and Streams Permit from the Michigan Department of Natural Resources.

13. Provide for on-site inspections during construction to assure conformance with approved development plans.

Stormwater regulations for the new developments should encourage innovative designs and layouts. Performance standards that provide adequate quantity and quality control but which do not dictate the shape or appearance of the retention/detention facility are recommended. The shape, location and appearance of stormwater facilities should be determined by qualified engineers following a careful review of the site.

Recommended Stormwater Facility Design, Construction, and Maintenance Activities

The program area of stormwater facility design, construction, and maintenance can be divided into two categories:

- Design and construction of areawide stormwater facilities, including storm drains and retention facilities;
- Maintenance of public and private stormwater facilities.

Activities related to each category are outlined below.

The design and construction of areawide stormwater facilities, including the acquisition of natural lands and the construction of retention/detention basins, is a relatively new area of local government activity. In a number of cases, the use of larger, community retention/detention areas can provide added stormwater management and financial benefits. Local governments engaged in such projects should first undertake stormwater planning to identify the locations of potential areawide retention/detention facilities and develop a financial strategy. In some cases, the local government will need to acquire land, construct, and maintain areawide facilities.

The maintenance of stormwater retention/detention areas and facilities (including natural and man-made retention/detention areas) is essential for continued functioning. The necessity of trash removal, grass cutting, and other housekeeping practices is generally recognized. Regular pump maintenance is also recognized. Because many retention/detention basins and areas are new, structural maintenance needs including sediment removal and repairs have often not become apparent. Nevertheless, the clear experience of communities which have had retention/detention basins in place for ten or more years is that regular maintenance is essential.

Local government programs related to facility design, construction, and maintenance will obviously refect the local government's approach to governmental services. In a rural community where the local government provides a minimum of public services, direct involvement in facility design, construction and maintenance will often be difficult. In such cases, the role of the local government is to assure that some other party or agency (such as the drain commissioner) is responsible for facility maintenance and areawide facility construction. In jurisdictions where community planning and public works services and programs are in place, the expansion of programs to include stormwater management may not be difficult. In the area of maintenance, for example, trucks and other equipment needed for sanitary wastewater treatment facility activities are often useful for stormwater facility maintenance.

Realizing that local governments will have different program response capabilities, the following guidelines are recommended for consideration in the program development process:

1. Consider the feasibility of acquiring wetlands and lowland areas to serve as areawide stormwater retention/detention areas (this is also related to stormwater management planning). Can existing parks and recreation lands acquisition programs be used to meet stormwater management needs?

2. Define the types of maintenance required by certain types of stormwater facilities. If at all possible, provide for public inspection of all retention/detention basins to ensure that proper maintenance has been carried out. Special development fees may be required to finance a continuing retention/detention basin inspection program.

3. Assure that retention/detention basin maintenance is a clearly assigned responsibility. The type of maintenance activity to be carried out should be understood by the responsible party and the local government. In cases where homeowners' associations or individual property owners are to be responsible for retention basin maintenance, agreements which allow the local government to step in and complete necessary maintenance activities in the event maintenance is not performed are recommended.

4. Consider the feasibility of a public retention/detention basin maintenance program financed through developer's fees.

As reflected by these guidelines, the specific features of a local government stormwater facility maintenance or areawide facility construction and maintenance program will vary. Effective stormwater management, however, does necessitate some type of inspection and maintenance program.

DESCRIPTION AND ANALYSIS OF CASE STUDIES

Stormwater management programs from five case study communities are highlighted in this section and compared with each other. The rationale for stormwater management in each case study area is identified in the section which follows. The conclusion to this chapter then reviews:

- Description of Planning Programs
- Analysis of Planning Programs
- Description of Regulatory Programs
- Analysis of Regulatory Programs
- Description of Facility Construction and Maintenance Programs
- Analysis of Facility Construction and Maintenance Programs

Detailed case study reports are included in Appendix A.

Rationale for Stormwater Management

A comparison of the reasons for the adoption of stormwater management programs in each of the five communities is a useful introduction to the case studies. The primary factors, as articulated by the elected officials, staff, and consultants interviewed, are the following:

- City of Farmington Hills - The cost of storm drain construction to alleviate flooding problems was estimated to be $80 million in 1974. Realizing that such costs were beyond the means of the City, Farmington Hills adopted an on-site stormwater regulatory program and related maintenance requirements for homeowners' associations. Experience with on-site regulations has led to the recognition that areawide retention/detention areas could be a useful supplement to on-site retention/detention requirements, and a stormwater planning study is now in progress.

- Oakland Township - Oakland Township's stormwater management strategy and program has been formulated over the past ten years through a series of technical studies and planning efforts involving elected officials and interested cities. As a result of the land use and open space plan and discussions concerning wetlands and floodplains protection, the Township became increasingly aware of the importance of protecting the natural hydrologic system for water quality and water quantity control purposes. In 1980, a stormwater management plan was adopted which reflects the view of the Township that natural areas should be retained and used for stormwater retention/detention purposes whenever possible. The plan serves as the regulatory framework for development plan reviews. The Township will assume responsibilities for retention/detention facility maintenance.

- Pittsfield Township - Pittsfield Township officials decided to require on-site retention/detention of stormwater in new developments in the late 1960's when the Township was beginning to develop. Financial, water quality control, and flood prevention factors combined to influence local policies. The Township provides only the most essential services to residents in order to maintain low property taxes. Retention/detention facility maintenance is considered the responsibility of private owners or the Washtenaw County Drain Commissioner.

- City of Sterling Heights - The small size of certain drainage courses in Sterling Heights has led to stormwater retention/detention requirements in certain areas. Without stormwater retention/detention requirements in certain areas, local flooding would be a continual problem. Areas discharging to large rivers are not subject to retention/detention requirements. In view of financial difficulties with storm drain construction, the City expects that retention/detention facilities will be considered permanent in the future. As an extension of its other public works activities, the City carries out a comprehensive retention/detention facility inspection program and performs maintenance on a number of basins in the City.

- City of Troy - In the mid-1960's, Troy adopted retention/detention requirements for new developments in order to avoid local and downstream flooding. In the late 1960's, retention/detention standards were influenced by requirements of the U.S. Army Corps of Engineers for restricted discharges into the Red Run branch of the Clinton River. Without the construction of drain improvements proposed by the Corps of Engineers, flooding would result from storm drain connections to the system. Due to storm drain improvement financing difficulties, Troy officials now consider it likely that retention and detention facilities will be permanent. The Department of Public Works inspects and maintains a number of stormwater basins in the City.

Financial limitations for storm drain construction projects, flooding, and water quality concerns are the dominant reasons for stormwater management programs involving on-site retention and detention in the case study communities.

Description of Planning Programs

Although each of the case study communities has or is undertaking some type of plan preparation activity, the type of planning activity is highly varied. Aspects of planning activities are tabulated and compared on Table 1.

Pittsfield Township's Comprehensive Plan, for example, states the basic stormwater management policy of the Township and highlights the relationship of stormwater conveyance and storage areas with Pittsfield's open space and recreation objectives. It is proposed that the Township take a lead in assuring that creeks and other natural waterways be retained in their natural conditions.

Oakland Township's Storm Water Management Plan, one element in a comprehensive planning program, is based upon the philosophy that the retention of natural

TABLE 1

STORMWATER MANAGEMENT PLANNING PROGRAM COMPONENTS*

	Farmington Hills	Oakland Township	Pittsfield Township	Sterling Heights	Troy
Goals Development Process with Public Participation	No	Yes	No	No	No
Stormwater Management Data Base, including Natural and Manmade Stormwater Conveyance and Retention Areas	Yes	Yes	No	No	No
Policy Plan for Stormwater Management	Yes	Yes	No	No	No
Plan Showing Location of Proposed Storm Drains and Community Retention Facilities	(in Preparation)	None Proposed	No	(Storm Drains)	(Storm Drains)
Plan which Considers Relationship of Stormwater Management Policies with Recreation, Wetlands, Floodplain Management, etc.	Yes	Yes	Yes	No	No
Plan which Identifies Alternative Approaches and Techniques for Stormwater Management	Yes	No	No	No	No
On-Going Stormwater Program Review and Revisions	Yes	Yes	Yes	Yes	Yes
Plan with Strategies for Alleviating Existing Flooding and/or Pollution Problems	(in Preparation)	No	No	No	No

*See case study reports in Appendix A for further information.

areas and their use for stormwater storage and conveyance will help preserve the rural character of the Township. Oakland Township's plan is used as a policy and decision-making document for development plan reviews.

In contrast to the Pittsfield and Oakland Township emphasis on natural areas, the Sterling Heights' Master Drain Plan (developed in the early 1970's) shows the proposed location of storm drains throughout the City. The City of Troy's Storm Drain Plan similarly emphasizes the location of improved drains.

Farmington Hill's ongoing planning program is expected to result in a different type of master storm drainage plan. Rather than focusing on the removal of stormwater from the City through drain construction, the plan will view stormwater as a resource, to be retained within the community with multiple benefits to City residents. Areawide retention areas and financing schemes are being considered through the planning effort. Remedies to flooding problems in developed areas are also being explored.

Although each of the case study communities is aware of stormwater flows from adjacent communities, none of the case studies has engaged in inter-community stormwater management planning. With the exception of Sterling Heights, each of the communities is sufficiently large in geographic area to be able to address many local flooding concerns. Also, all case study communities except Sterling Heights are at or near the headwaters of the watershed.

Revisions to stormwater management regulations have been made on a regular basis in many of the case study communities. The inter-relationships of stormwater management with other local government programs is explored for particular projects or development proposals. Sterling Heights is developing a strong coordination effort between stormwater management facilities and recreation areas. Oakland Township has emphasized the inter-relationship of stormwater management with natural areas and wetlands protection.

Analysis of Planning Programs

Comprehensive stormwater management planning involving the development of objectives, data analysis, identification and evaluation of alternative strategies, implementation, and on-going program monitoring is recommended in this report. With the possible exception of Farmington Hills, the case study communities do not have planning programs of this scope.

Extensive stormwater management planning has not been carried out for several reasons. First, the central importance of stormwater management activities and the need for community-wide planning to develop policies, strategies, and to identify areawide retention areas has only recently been recognized. In Sterling Heights and Troy, for example, retention/detention facilities have been considered as temporary structures until recently. Extensive planning for temporary structures would not be warranted. Second, there is no readily available source of funding for stormwater management planning activities. Finally, planning is often preventative with a long-term time focus. With competing demands on public funds, planning sometimes receives a low priority.

Stormwater management planning is generally regarded as a technical activity carried out by engineers. A consideration of alternative strategies and policies and their effects has not been requested by elected officials. As the range of stormwater management policy and program options is realized it is expected that more extensive policy planning with the evaluation of alternatives by the public and officials will be undertaken in Southeast Michigan.

Description of Regulatory Programs

Each of the case study communities reviews large and small site plans and subdivision plats to ensure that stormwater is properly managed in new developments. On-site retention/detention of stormwater is a central regulatory feature in each of the case studies. Elements of the regulatory programs in each case study are outlined on Table 2.

With the exception of Oakland Township, stormwater regulations in the selected communities typically lead to parking lot stormwater storage on small sites (one acre or less) and retention or detention basins on larger sites. The reviewing engineers do not encourage a particular shape or type of basin, but rather consider the merits of the site. Consulting planners, engineers, and the local planning commissions encourage the development of attractive basins which are assets rather than liabilities for the development. In Oakland Township, requirements for use of natural drainage areas are applied to both large and small sites.

All of the case study communities except Sterling Heights apply retention/detention regulations through the community. By providing a uniform approach, the communities feel that they can avoid court challenges and provide an equitable regulatory system. In Sterling Heights, two areas of the city which drain into large waterways are not subject to detention requirements.

Retention/detention basin capacity for at least the runoff from a ten-year frequency storm is required in all cases. Oakland Township, Pittsfield Township, and the City of Troy require capacity for runoff from a 100-year frequency storm or more. In Oakland Township, engineers preparing site plans and subdivision plats are required to provide for a primary drainage system designed to carry runoff from storms up to a 10-year frequency and a secondary system for carrying runoff from storms up to a 100-year frequency without causing damage to adjacent properties.

Oakland Township and Pittsfield Township encourage the use of natural areas and lowlands for stormwater retention/detention when site conditions allow. In Farmington Hills, lack of land area on most development sites precludes the extensive use of natural areas. Soil conditions in much of Troy and Sterling Heights prevent the use of natural infiltration policies. Oakland Township's Floodplain and Wetlands Ordinance is a central element in the Township's stormwater management regulatory program. The Ordinance helps to ensure that natural areas with stormwater retention/detention capabilities remain unaltered. Wetlands and floodplain protection, in turn, leads to natural infiltration of stormwater to the ground.

All of the case study communities except Oakland Township have adopted erosion and sedimentation control ordinances in accordance with the Michigan Erosion and

TABLE 2

STORMWATER MANAGEMENT REGULATIONS FOR DEVELOPMENT PLAN REVIEWS*

	Farmington Hills	Oakland Township	Pittsfield Township	Sterling Heights	Troy
On-Site Retention of Stormwater with Agricultural Rate of Discharge Required	Yes	Yes	Yes	Required in Three Drainage Districts	Yes
Retention Capacity for 10-Year Frequency Storm Required	1.65 - 2" Over Entire Site	Yes	Yes	2" Over Entire Site	Yes
Retention Capacity for 100-Year Frequency Storm Required	No	Yes	Yes	No	3-1/2" Over Entire Site
Natural Infiltration of Stormwater On-Site Encouraged	No	Yes	Yes	No	No
Wetlands Protection Ordinance Adopted	No	Yes	No	No	No
Grading Plans Reviewed for Potential Erosion Problems	Yes	Yes	Yes	Yes	Yes
Erosion and Sedimentation Control Ordinance Adopted	Yes	No	Yes	Yes	Yes
Cluster Development Encouraged to Preserve Open Space Areas	Yes	Yes	Yes	Zoning Option Not Frequently Used	Yes
Regulations Protect Floodplains as Natural Areas	In Many Cases	Yes	No	Yes	No

*See case study reports in Appendix A for further information.

Sedimentation Control Act (Act 347, P.A. of 1972). Oakland Township is a general law township and is not permitted under state law to adopt such an ordinance. Erosion control regulations focus on the control of sediment during the construction phase of the development.

The erosion and sedimentation control ordinances require the preparation of an erosion control plan for the proposed development. As a supplement to the erosion control plan, all of the case study communities review grading plans at an early stage in the development review process. In some cases, the grading plan and the erosion control plan are the same document. In the review of grading plans, efforts are made to ensure that the area of soils exposed (especially on steep slopes) is minimized. Grading plan reviews are used to identify potential stormwater runoff and sedimentation problems during and after construction.

Cluster development options for residential developments are referenced in the zoning ordinances of each of the case study communities. Cluster development provisions are typically enacted to allow the developer to make profitable use of his property while providing open space and recreation areas for residents. Cluster development has been particularly important for open space preservation in Farmington Hills and Troy. Although none of the case study communities intentionally use cluster development as a stormwater management tool, the benefits of open space areas for slowing stormwater flows are generally recognized.

Analysis of Regulatory Programs

Stomwater management regulations for new developments are a priority stormwater program in the case study communities. Oakland Township, Pittsfield Township, and Farmington Hills emphasize the importance of their stormwater regulations as an alternative to storm drain construction projects. In Sterling Heights and Troy, retention/detention regulations developed in the 1960's were considered as a necessary interim measure until storm drains were constructed. Stormwater management philosophies in Sterling Heights and Troy are changing, however, and it is now recognized that on-site retention and detention of stormwater will probably be a permanent alternative to drain construction in a number of areas of the cities.

The use of natural areas such as lowlands and wetlands for stormwater retention and detention has been recommended in this report as an approach which typically enhances water quality. Oakland Township is the only case study community which emphasizes the use of natural areas for stormwater management. It is expected, however, that if areawide retention/detention facilities are proposed, the use of wetlands and lowlands for stormwater management will become more prevalent. The fact that the use of lowlands and wetlands for natural infiltration are not emphasized reflects the fact that water quality protection is not a central goal in most of the stormwater regulations. Concerns about mosquitoes and standing water are other factors influencing community policies on natural areas for stormwater management.

Officials in the case study communities recognize that erosion and sedimentation control ordinances, floodplain regulations, and open space preservation regulations can have stormwater management benefits. With the possible exception of Oakland Township, however, the conceptualization of a comprehensive stormwater management program has not occurred. Stormwater requirements for on-site retention/detention and discharge are generally considered to be the primary stormwater regulatory program, and the effects of other regulations on stormwater management have not been formally analyzed.

Erosion and sedimentation control is generally regarded by the case study communities as an important regulatory program for stormwater runoff control during construction. Erosion and sedimentation control requirements are not generally applied to the design of retention facilities, however. Instead, retention facilities are reviewed through stormwater engineering requirements which focus on stormwater capacity and flows -- not on erosion and sedimentation capabilities of basins.

Overall, the case study communities have developed strong regulatory programs for stormwater management in new developments. Stormwater regulation is considered to be a government management activity of equal importance to proper sewage disposal and water supply. Many of the specific regulations have water quality benefits, although they were developed primarily for flood control purposes.

The case study communities have also recognized the importance of writing down and adopting stormwater regulations so that developers are apprised of the requirements before development plans are prepared. Oakland Township, Farmington Hills, Pittsfield Township, and Troy have policies and regulations which have been adopted by the local governing boards. In Sterling Heights, the regulations are not officially adopted by the governing boards, but are administered by staff and consultants in a uniform manner.

Description of Facility Construction and Maintenance Programs

The approaches taken to stormwater facility maintenance in the case study communities are varied. Each community, however, emphasizes the importance of stormwater facility maintenance and tries to use existing governmental agencies to assure that maintenance is carried out in large developments. The possibility of constructing stormwater retention/detention facilities to serve a sizable area are being explored by Farmington Hills and Sterling Heights. Pittsfield Township is encouraging the provision of community retention/detention areas in selected locations throughout development reviews. Table 3 summarizes the major features of the local construction, operation, and maintenance programs.

Oakland Township, Sterling Heights, and Troy have estabished local government retention basin maintenance programs. Maintenance programs in Sterling Heights and Troy have been in operation for at least ten years. In Oakland Township, the policy and program are just being established. In all three cases, local officials believe that direct local government maintenance is a necessary service. In Sterling Heights and Troy, developers pay for the long-term cost of facility maintenance at the time that development plans are approved.

TABLE 3

CONSTRUCTION, OPERATION, AND MAINTENANCE PROGRAMS FOR STORMWATER RETENTION/DETENTION FACILITIES*

	Farmington Hills	Oakland Township	Pittsfield Township	Sterling Heights	Troy
Retention Basin Inspection and Maintenance by Local Government	No	Yes	No	Yes - Some Cases	Yes - Some Cases
Retention Basin Inspeaction and Maintenance by Drain Commissioner	No	No	Yes - Encouraged for Large Developments	Yes - Some Cases	No
Retention Basin Maintenance in Subdivision Plats by Homeowner's Associations	Yes	No	No	No	Yes - Some Cases
Retention Basin Maintenance by Property Owners	Yes, If Not a Subdivision Plat	No	Yes, If Not a Major Development	Yes, with City Inspection	Yes, If Not a Subdivision Plat
Program for Construction of Community Retention Facilities	Options Being Reviewed	No	Provided Through Development Plan Approvals	Program Being Initiated	One Community Retention Area

*See case study reports in Appendix A for further information.

The City of Farmington Hills has been successful in designating homeowners' associations as the responsible organization for facility maintenance. Retention basin maintenance is one facet of assigned responsibilities for open space maintenance in certain subdivisions. The City enters into legal agreements with developers, and developers, in turn, place deed restrictions on all properties in the development. The restrictions assure that the homeowners' association has the right to charge residents for maintenance costs and provides the City with the legal right to intervene if proper maintenance is not carried out. Specific retention/detention basin maintenance requirements, however, are not specified in the agreement.

Most retention/detention basins being maintained by homeowners' associations in Farmington Hills are relatively new, and structural maintenance or sediment removal has not been necessary. City staff believes that a more direct maintenance program by the City may be necessary at some time in the future. For example, through agreements with homeowners' associations, the City could repair basins and charge the homeowners' association for the service. The City of Troy also allows developers to assign maintenance responsibilities to homeowners' associations, although maintenance by homeowners associations has not always been successful.

Pittsfield Township relies upon the Washtenaw County Drain Commissioner to provide retention/detention basin maintenance services for subdivisions. When a subdivision plat or large development is proposed, Pittsfield encourages the landowner to make arrangements with the Drain Commissioner. The Drain Commissioner reviews and approves the basin design and establishes a drainage district for maintenance purposes. Landowners within the district are assessed the cost of basin maintenance.

Sterling Heights' facility maintenance program includes the inspection of all retention and detention basins in the City as well as maintenance on certain designated basins. Inspection fees are included in charges made for site plan and subdivision plat reviews. Maintenance responsibilities are enumerated in retention basin maintenance agreements which are signed by landowners before development plans are approved. The City inspects retention/detention basins on a weekly basis and notifies landowners if basins and pumps are not maintained or functioning properly. Actual maintenance is the responsibility of the landowner unless special arrangements have been made with the City of Sterling Heights or the Macomb County Public Works Commissioner.

Analysis of Facility Construction and Maintenance Programs

With the exception of Pittsfield Township, the case study communities have developed their own programs for stormwater facility maintenance. In Pittsfield Township, maintenance is the responsibility of the Washtenaw County Drain Commissioner or the property owner.

It is difficult to generalize about the applicability of Farmington Hill's experience with homeowners' associations to other jurisdictions. In Farmington Hills, open space amenities are important assets in residential developments and for the most part the homeowners' associations have taken appropriate and responsible actions for open space maintenance. Whether homeowners' associations will be able to undertake substantial retention basin maintenance, however, is uncertain. Farmington Hills recognizes that some oversight by the City will be needed.

The evolution of maintenance programs in the case study communities reflects the growing recognition among engineers and stormwater mangement specialists that maintenance is essential for proper functioning. Sterling Heights, Troy, and Farmington Hills have had retention requirements for ten years or more. Maintenance programs have been developed in response to the community's experiences with retention/detention basins. Oakland Township has adopted its policy concerning maintenance as a prevention strategy, recognizing the long-range need of the Township for a systematic program approach to stormwater facility maintenance.

IMPLICATIONS OF CASE STUDIES FOR OTHER SOUTHEAST MICHIGAN COMMUNITIES

The experience of the case study communities with stormwater management emphasizes several important points. As communities in Southeast Michigan review and refine their stormwater management regulations and consider approaching stormwater management in a comprehensive manner, the experiences of the communities as reported here should be considered.

In summary, the major findings from the case studies are as follows:

1. Stormwater management policies, programs, and regulations should be established in order to provide a uniform and equitable approach to development. To be fair to land owners and developers, policies should be adopted by the local governing board and clearly articulated through written materials.

2. Stormwater facilities can be designed so that they are attractive amenities in the development. Careful engineering reviews and discussions with developers' engineers are needed to ensure that basins are assests in new developments.

3. For financial, water quality, and water quantity control reasons, policies supporting on-site retention/detention of stormwater can be effective approaches to stormwater management. An increasing number of communities are recognizing retention and detention as a useful alternative to storm drain construction.

4. Stormwater management planning programs are an important complement to stormwater regulations. Stormwater management planning is particularly important if community or areawide retention/detention facilities are proposed or if there are opportunities for coordinating stormwater management programs with open space, recreation, groundwater protection, wetlands management, or floodplain management programs.

5. Stormwater facility maintenance is an essential component of a local government stormwater management program. To ensure proper facility maintenance, local government programs or programs of the county drain commissioner are usually necessary.

Officials, staff, and consultants interviewed for this report frequently emphasized that they had gradually evolved their stormwater management philosophy and programs over time, and that they expected to continue to revise their program approaches. Several persons interviewed noted they wished that more information from other communities had been available when they initiated their stormwater management programs. It is hoped that this report will facilitate stormwater management program development options of local governments in Southeast Michigan.

APPENDIX A

STORMWATER MANAGEMENT CASE STUDIES

The chief elected official and appropriate staff and consultants from each case study community were interviewed to obtain information about stormwater management programs in the selected case study communities. Drafts of the case study reports were prepared for review by persons interviewed, and subsequent revisions made.

The case study reports are as follows:

- City of Farmington Hills
- Oakland Township
- Pittsfield Township
- City of Sterling Heights
- City of Troy

Each report includes an introduction reviewing community characteristics and the stormwater management philosophy of the community; a summary of stormwater management planning, regulatory, and operations/maintenance activities; and a review of innovative stormwater management features.

The extensive assistance of persons interviewed is gratefully acknowledged. Interested readers are encouraged to contact the persons listed at the end of each report for further information.

CITY OF FARMINGTON HILLS

STORMWATER MANAGEMENT CASE STUDY

PART I: INTRODUCTION

Community Characteristics

The City of Farmington Hills is located in south central Oakland County at the headwaters of the Rouge River. The Township of Farmington and several villages were incorporated in 1973 to become the City of Farmington Hills. As a result, the geographic area of the City is nearly equivalent to a Michigan township (33 square miles).

Rapid urban development characterized Farmington Hills in the 1970-1980 decade. Between 1970 and 1980, population increased from single-family homes and multiple dwellings in attractive subdivisions as well as growth in the light industrial sector have been dominant trends. The rolling terrain and wooded hillsides of Farmington Hills have encouraged attractive developments with landscaping and open space preservation.

Municipal water and sanitary sewer services from the City of Detroit are available in most areas of the City. A few areas utilize water supply wells. In some of the older areas of the City, storm sewers have been constructed. Small local storm sewers connecting subdivisions with stormwater retention areas are prevalent. Some large connector storm sewers are located throughout the City. Most areas in Farmington Hills are not served by major storm sewers.

Stormwater Management Philosophy

Over the past decade, Farmington Hill's philosophy of stormwater management has changed from the view that stormwater should be removed from development sites as quickly as possible to the view that stormwater runoff is a resource which should be retained on-site for recreational and other beneficial uses.

Farmington Hill's early philosophy was based upon predominant engineering practices at the time. The City completed a storm drain plan which indicated the locations and sizes of enclosed and open drains to remove stormwater from land throughout the City. The estimated cost of the plan in 1974 was $80 million -- well beyond Farmington Hills' financial capability. At the same time that cost problems were becoming apparent, potential downstream effects of the drainage policy became apparent. Since Farmington Hills is at the headwaters of the Rouge River, all downstream communities would receive their stormwater runoff.

Preceding page blank

The new philosophy of stormwater management as presently practiced by the City is designed to solve flooding and stormwater management problems for new developments, while reducing overall public costs. Ways to alleviate existing flooding problems within the framework of the new philosophy of stormwater resource management are being investigated.

Stormwater Management Program Overview

Farmington Hills regards stormwater management as a public utility and service, similar to sanitary waste management and water supply management. It is the general policy of the City to charge landowners benefiting from utility services for the cost of the services.

The primary emphasis of the City's stormwater management program is the regulation of new development. Site plans and subdivision plats are reviewed and compared with the City's engineering design standards for stormwater management and erosion control. On-site detention or retention of stormwater is required for all new developments, regardless of the size of the receiving stream.

In future years, the City may become involved in the construction and maintenance of retention facilities to receive stormwater from several properties. Future stormwater management needs and implementation approaches are being investigated in a planning study.

As part of its community planning activities, Farmington Hills has strongly encouraged the preservation of open space and natural areas. The use of the planned unit development option and the planned residential option (specified in the Zoning Ordinance) has allowed for cluster development with common open space areas. The open space areas, in turn, have helped to hold and detain stormwater. The open space preservation policies, therefore, have provided stormwater management benefits which were not initially anticipated. Through the new Master Storm Drainage Plan, lowland areas and wetlands which can serve an important stormwater detention function will be identified.

Major activities, policies, and standards related to stormwater management in Farmington Hills are summarized below. Emphasis is placed on policies which have water quality benefits.

PART II: STORMWATER MANAGEMENT PROGRAM DESCRIPTION

Planning Program

Approximately ten years ago, the City of Farmington Hills adopted a storm drain plan which identified the location of existing and proposed storm drains necessary to remove surface stormwater runoff. In 1974, the estimated cost of implementing the plan through construction of new storm drains was approximately $80 million.

A new master storm drainage plan based upon a different philosophy of stormwater management is now being prepared. Rather than focusing on the rapid removal of stormwater, the plan will view stormwater as a resource, to be retained on-site with multiple benefits for city residents.

The drainage plan will provide the following:

1. An ultimate drainage system, capable of accommodating the runoff generated by a specified design storm.
2. An ultimate drainage system for the major Rouge River tributaries, capable of accommodating a 100-year storm, consistent with state and federal requirements.

The term "drainage system" refers to all facilities which provide for the collection, storage and transport of stormwater from sites throughout the City. Factors to be investigated in the study include:

- Existing stormwater facilities:
    - storm sewers
    - open ditches
    - detention basins
    - lowlands
    - vegetative covers
- On-line check dams
- Regional storage facilities which may be necessary in the future
- Soil investigation as related to generation of runoff
- Adaptability of system to recreation facilities
- Investigation of controlled flooding throughout the City
- Use of a cost/benefit analysis
- Downstream and upstream considerations beyond the city limits

Solutions to existing flooding problems as well as stormwater facilities which will avoid future problems will be identified. Recommendations for maintenance of the drainage system, including financing of maintenance activities, will be included. The projected completion date for the study is Spring, 1981. Local tax revenues are being used to finance the $130,000 study.

Regulatory Programs

The City of Farmington Hills reviews subdivision plats, site plans, and plot plans to ensure that new developments conform with adopted policies and standards. Regulations and ordinances which affect stormwater management include the following:

- Site Plan Design Standards for Retention
- Open Space Development Options (Zoning Ordinance)
- Flood Damage Prevention Ordinance
- Erosion and Sedimentation Control Standards and Ordinance

Major provisions of these regulations are summarized below.

A. Site Plan Design Standards for Retention

Any site that utilizes an unimproved outlet for drainage must retain the increased runoff on-site. The actual effect of this requirement is the retention or detention of stormwater on small and large site plans and subdivision plats.

Retention must be provided for a stormwater volume equivalent to the following depth of water over the entire site:

single family:	1.65 inches
multiple:	1.85 inches
commercial and industrial:	2.00 inches

Volume requirements are specified in inches rather than storm frequency in order to simplify storage calculations. Farmington Hills' standards result in storage of stormwater which exceeds the equivalent volume for a 10-year frequency storm. Discharge from the site is limited to 0.1 cfs/acre. If the basin does not have an outlet, capacity at least equivalent to storage for a 100-year frequency storm is required.

Retention and detention basins with side slopes exceeding one foot vertical to six feet horizontal must be fenced. The City encourages the design of basins with gradual side slopes and no fences, since such designs are more attractive and facilitate the use of basins for recreation. Basins must be constructed to drain entirely unless designed to retain a permanent water level which conforms to the aesthetics of a landscape plan.

Farmington Hills also has adopted specific engineering standards related to right-of-way drainage. Enclosures of drainage ditches are generally not permitted. Open ditches are preferred because they slow stormwater flows, allow some detention of stormwater, and reduce immediate flows of stormwater into receiving streams. Enclosed drain systems along roadways may be permitted in special cases.

Although natural infiltration of stormwater is considered desirable, it is not generally considered feasible as a stormwater management technique for meeting retention requirements because of the high cost of land.

B. Open Space Development Options

In 1969, Farmington Township adopted a "planned residential district" development option as part of the Zoning Ordinance (Farmington Township became the City of Farmington Hills in 1973). The Planned Residential District allows a mixture of types of dwelling units and preserves open spaces. At least one-third of the total bedrooms in residential units must be single-family homes, and at least 25 percent of the total gross land area within the project must be park or open spaces. A minimum of 50 detached single-family homes must be included within each planned residential district. A development plan for the site (including the proposed stormwater drainage system) must be submitted for review and approval.

A planned unit development option and a cluster option are also included in the present Zoning Ordinance. The purpose of a planned unit development is to preserve open space while allowing a reduction in lot sizes for residential units. The purpose of the cluster option is to provide through design innovation an alternative means for development of single-family areas in conjunction with open space.

Although the specific development and density requirements of the planned residential district, and the planned unit development options are different, the intent and general effect is the same. Both options allow developers more flexibility in meeting housing market needs, while providing large areas of common open space. Although not directly intended for stormwater management purposes, the open spaces (which include rolling topography and wooded lots in many cases) hold stormwater temporarily and allow more natural infiltration of stormwater than would otherwise occur.

The City of Farmington Hills encourages open space preservation for all development proposals, even if the open space development options are not used. To assist the City in completing development reviews, an environmental inventory which identifies wetlands, water bodies, and areas of steep slopes has been completed. The inventory allows the City to identify potential development problems or hazards which require examination in the site plan or subidivision plan review process.

C. Flood Damage Prevention Ordinance

The stated purpose of the Flood Damage Prevention Ordinance (Chapter 66 of the City Code) is to reduce flood hazards and damages. The effect of the ordinance, however, is to provide substantial protection to natural floodplains and wetlands within the floodplain. When left in their natural state, floodplains and wetlands have substantial absorption and detention value.

The Ordinance requires approval by the City Engineer of any new construction within special flood hazard areas (the 100-year floodplain, as defined by special studies completed by the U.S. Department of Housing and Urban Development). Within the floodway, encroachments and new construction are prohibited if any increase in flood levels would result. In the floodplain fringe, the City Engineer reviews new construction proposals in accordance with principles of compensating excavation whereby the storage volume that exists within the floodplain is retained.

D. Erosion and Sedimentation Control Standards and Ordinance

The City of Farmington Hills has adopted an Erosion and Sedimentation Control Ordinance in conformance with the Michigan Soil Erosion and Sedimentation Control Act. All development plans which are one acre or more in size or within 500 feet of a lake or stream are subject to the permit requirements. Straw bale berms and stone filters are often required. Sediment basins or traps are sometimes required in large subdivisions.

The City encourages basic erosion and sedimentation control practices for site plans and plot plans for single-family homes (whether or not the home is part of a large subdivision) although there are no requirements. When single-family homes are constructed on steep slopes, for example, straw bales are often provided by the developer on a voluntary basis. The City reviews development plans and makes recommendations for changing the location of structures or the amount of area exposed during construction, when needed.

E. Development Review Fees

Development review costs incurred by the City of Farmington Hills (including engineering and planning consultant costs) are largely covered through fees paid by developers. Five types of fees are collected:

1. Acreage Review Fee: Non-refundable fee required at the initiation of review procedures.

   $100.00 for the first acre and an additional $25.00 for each additional acre.

2. Zoning Review Fee: Non-refundable fee required at the initiation of review procedures.

3. Utility Review Fee: Deposited prior to plan approval.

   1.3 percent of the construction cost for all public watermain, public sanitary sewer, public paving, and drainage improvements, where applicable.

4. Inspection Fee: Cash amount deposited in an escrow account to cover the costs of city engineering inspection and testing. The deposit amount is based on the construction cost of all public watermains, sanitary sewers, storm sewers, and paving that requires engineering inspection. For example, if construction costs range from $50,000 to $100,000, a 6 percent deposit (but not less than $4,000) is required.

   Inspection fees are then billed at an hourly rate of $19.00/hour regular time. Upon the final approval of the site following construction, the cash deposit amount which has not been used in paying inspection fees is returned.

5. Soil Erosion Fees: A special fee for a soil erosion and sedimentation control permit is required. The charge is $80.00 for the first acre or a fraction thereof, and $40.00 for each additional acre up to 10 acres. A fee of $20.00/acre is charged for every acre over 10 acres.

   In effect, the costs of regulating new development are covered by the property owners involved. The fees listed above apply to site plans and subdivision plats. City officials strongly feel that costs to residents for city services (and hence the city services themselves) should be kept to a minimum. The "user pays" policy is one way to implement this philosophy.

Operation and Maintenance Programs

The City of Farmington Hills owns and maintains many storm drains within highway rights-of-way. At present, the City does not maintain retention or detention facilities.

In the future, it is possible that the City will become directly involved in the construction and maintenance of basins to serve several areas. The question of maintenance programs and City responsibilities is being addressed through the stormwater planning study.

When retention or detention basins are included in subdivision developments, a development agreement which provides for maintenance of stormwater facilities (as well as common open space areas) must be signed. Developers then include restrictive deed covenants in the property deeds which provide for the maintenance of facilities by homeowners' associations. Specific provisions of typical development agreements include the following:

- Title to the common area must be vested in the association.

- The association must be organized as a non-profit corporation for a perpetual term. Membership in the association is mandatory for each home buyer and any successive owner of residential lots within the subdivision.

- The association must be responsible for the proper maintenance of open spaces. The association must have the authority to make and enforce regulations pertaining to the use and maintenance of the common area, which regulations are binding upon lot owners.

- The common area may be used for the following purposes:

  - Recreational purposes consistent with the development plan approved by the City; and

  - Drainage and/or water retention area as approved by the City.

- In the event that the association fails to maintain the common area in reasonable order and condition, the City may serve written notice upon the association or upon the lot owners, and must include a demand that deficiencies be cured within 30 days. If the deficiencies are not corrected, the City, in order to preserve the taxable values of the properties and to prevent the common area from becoming a public nuisance, may maintain the area for a one-year period. The costs of the maintenance, including reasonable administrative costs, must be assessed equally against all property and becomes a lien on the property. If the association is unable to assume maintenance responsibilities at the end of the year, the City may continue maintenance activities.

Specific maintenance requirements for retention and detention basins are not stated in the agreement. Typical basin maintenance activities carried out by homeowners' associations on basins include grass cutting, trash removal, and side stabilization. Small amounts of sediment removal may be necessary in the future. To date, associations in the City have responsibly carried out maintenance tasks and taken pride in attractive common areas.

Because stormwater flows over wooded and grassed lands which retain sediment before stormwater reaches basins, significant sediment loads are not expected to accumulate. If sediment removal is needed, it is expected that the City would perform the operations and bill subdivision residents.

PART III: INNOVATIVE APPROACHES TO STORMWATER MANAGEMENT

Completion of Open Space Improvements

The City of Farmington Hills considers on-site inspections to be an essential part of its regulatory programs. One concern in the past has been the proper "finishing" of common open space areas in subdivision developments. Although some developers do an excellent job, certain developers leave common open space areas partially unfinished for very long periods of time. Since some of the final work in common open spaces relates to erosion and sedimentation, this is a particular concern for water quality. It is very important that retention basins which have been used for sediment control purposes during development be properly cleaned out. Open space areas must also be stabilized with vegetation in order to avoid further erosion. To address this potential problem, Farmington Hills establishes a target completion date for all site improvements and retains a special escrow account which can be used if the developer fails to complete the work. The City also requires the completion of all site work before common areas are turned over to the homeowners' association.

Erosion Control for Homesites within a Subdivision Plat

As required by the Michigan Soil Erosion and Sedimentation Control Act, (Act 347, P.A. of 1972), developments which are one acre or more in size or within 500 feet of a lake or stream must obtain an erosion control permit. The City of Farmington Hills is officially designated by the State to enforce provisions of the Act.

Farmington Hills applies similar erosion control requirements and standards to individual site plans and plot plans for single-family homes. Erosion potential of a site is reviewed when the grading plan is submitted (the grading plan is also reviewed to identify potential drainage problems).

The City has developed an innovative approach to an erosion control problem which arises when several builders construct homes in a single subdivision. Although the perimeter of the subdivision is protected from erosion until road construction is completed, additional erosion problems may be created by the construction activity on individual lots. Farmington Hills requires each home builder to have a grading plan for the site which conforms with the overall grading plan for the development. If the new home is sold without a grassed lawn, the City requires the builder to leave straw bales in place. A letter is sent to all new homeowners requesting that straw bales be left in place until permanent vegetative cover is provided, and explaining the potential concern about erosion from the site.

The City of Farmington Hills tries to communicate with developers about reasons for government regulations. A meeting in November, 1980, for example, focused on the City's erosion and sedimentation control requirements. The City revises its standards as needed, to ensure maximum protection of the public interest and an equitable financing scheme.

For Further Information:

Mayor Joann Soronen
City of Farmington Hills
31555 Eleven Mile Road
Farmington Hills, MI 48018
(313) 474-6115

Mr. Thomas P. Biasell, Engineer
City of Farmington Hills
31555 Eleven Mile Road
Farmington Hills, MI 48018
(313) 474-6115

Mr. Laurence G. Leeds, Planning Director
City of Farmington Hills
31555 Eleven Mile Road
Farmington Hills, MI 48108
(313) 474-6115

OAKLAND TOWNSHIP

STORMWATER MANAGEMENT CASE STUDY

PART I: INTRODUCTION

Community Characteristics

Oakland Township is a rural township north of the City of Rochester in northeast Oakland County. Several creeks which flow into the Clinton River traverse Oakland Township (the Township is in the upper portion of the Clinton River basin). The landscape is characterized by wooded lots, agricultural lands, scattered pockets of wetlands, and rolling hills.

Although the population of Oakland Township in 1970 was 4,800 persons, by 1980, the population had increased to 7,500 persons (estimate). Several subdivisions, private road development, and homes on individual lots have been constructed in the 1970's. The Township has no significant commercial or industrial development.

Oakland Township residents and officials are proud of the attractive, rural character of the area and intend that the Township retain its natural assets. Signs at the border read "Oakland Township -- A Planned Community in the Hills." As described in this case study, the Township has prepared a series of plans guiding the future growth and development of the community.

Reflecting the rural character, few areas of the Township are served by sanitary sewer or municipal water. Water supply wells and septic systems are used in the majority of instances. All major drains are unimproved open channel streams and meandering creeks.

Stormwater Management Philosophy

The stormwater management philosophy of Oakland Township is based on the premise that stormwater is a resource to be used. All natural resources should be managed to benefit the community and avoid harm in other locations. Therefore, in order to provide water to recharge groundwater supplies and support wetlands, and to avoid downstream flooding, Oakland Township has adopted a strong on-site retention policy for stormwater control.

Although Oakland Township is rural and has not directly experienced flooding problems, local officials are well aware of potential problems. The Township Board views their role as being one of preventing heartaches and headaches resulting from flooding.

Stormwater management is the most recent in a series of plan elements which have been adopted by Oakland Township. Early in the 1970's, the following plan elements were prepared:

- Survey of attitudes concerning future land uses
- Floodplains and wetlands protection ordinance
- Planned unit development ordinance which encourages developers to preserve the natural environment and use creative design
- Sewer service goals and policy
- Environmental impact statement requirements

These early ordinances and plan elements were then followed by:

- Comprehensive Development Regulation Plan (also called the Master Land Use Plan)
- New zoning ordinance and map
- Studies of costs and revenues of new development to determine how new development can pay for itself
- Dedication of parklands and trailways easements in all new developments to provide a continuous network of open spaces
- Ecological survey
- Studies of water resource management
- Vegetative cover protection ordinance
- Floodplain map
- Subdivision control ordinance
- Land division ordinance (to guide large acreage parcels and private roads)
- Master drainage plan and policy outlined which could control costs and environmental impacts of storm drainage
- Transportation plan
- Master drainage plan with emphasis on stormwater retention

To a large extent, the stormwater management program in Oakland Township is viewed as a tool for implementing the Township's land use and open space goals and policies. In fact, the preparation of the Storm Water Management Plan is a requirement of the Floodplain and Wetlands Ordinance.

Stormwater Management Program Overview

The Storm Water Management Plan adopted by Oakland Township in Spring 1980 serves as a regulatory framework for the review of all development proposals. The principles and standards in the plan are applied uniformly to all development proposals, including site plans, subdivision plats, and private road developments with large acreages.

Other elements of the stormwater management program include the grading plan reviews for erosion control purposes, floodplain and wetlands permit requirements, and environmental assessment requirements. Although Oakland Township does not own or maintain any storm drain or retention facilities at present, the Township has recently determined that maintenance of stormwater facilities should be a public responsibility.

Elements of Oakland Township's activities related to stormwater management planning, regulations and maintenance are described below.

PART II: STORMWATER MANAGEMENT PROGRAM DESCRIPTION

Planning Program

For the past ten years, Oakland Township has conducted a planning program for land use which has included the identification and mapping of sensitive resources, the development of policies to guide the future development of the township, and the preparation of a series of ordinances for regulating development.

The adoption of the Storm Water Management Plan in Spring, 1980 is the most recent part of the planning program. The Plan includes the following components:

- Statement of Principle
- Storm Water Management Policies
- Planning Requirements
- Design Requirements
- Standard Details for Blue-Green Detention Areas
- Design Criteria for Low Density Developments with Roadside Ditches
- Guidelines for the Preparation of the Comprehensive Drainage Analysis

An official drainage, floodplain, and wetlands map, a map of soil types, and technical information to assist engineers preparing development plans were also prepared as part of the stormwater management planning program.

35

The Storm Water Management Plan has been adopted by the Township and is to be used in reviewing site plans and subdivision plats. In effect, the plan is a substitute for adopted engineering standards for stormwater retention and on-site management.

The Statement of Principle is of central importance to the Plan. It reads as follows:

> "Oakland Township currently has an extensive system of natural drainage courses. These natural drainage courses are a valuable natural resource and a vital part of any drainage system. They have demonstrated their ability to safely carry the existing peak rates of runoff. It is, therefore, the intent of this plan to provide for the planning and design of all future developments such that the peak rate of storm water runoff from an area following development shall not significantly exceed the peak rate of runoff that occurred prior to development. As a result, the need to increase the capacity of the natural drainage courses will be minimized, making it easier to preserve them in their natural state."

Major stormwater management policies cover the following areas:

- No modification to a major drainage course is permitted when the primary purpose of the proposed modification is to increase the flow capacity of the drainage course.
- The 100-year floodplains of the major drainage course shall be maintained in their natural state to the greatest extent possible.
- The maximum allowable discharge from a proposed development shall not exceed the existing peak rate from the area (for a 100-year frequency storm).
- Oakland Township will be responsible for the maintenance of the storm drainage system, with the exception of drains under the jurisdiction of the Oakland County Drain Commissioner or the Oakland County Road Commission.

Planning requirements focus on the need to reduce the discharge of stormwater runoff from the site. As stated in the document, it is the intent of the plan to minimize potential problems by:

- Limiting the rate at which stormwater runoff may be discharged from a development;
- Allocating sufficient space within the development to attenuate the peak-developed flow rates; and
- Encouraging development concepts which will minimize the increase in the amount and rate of runoff generated.

All development proposals must be accompanied by a comprehensive drainage analysis. The "primary system" of open and/or enclosed drains which is designed to carry runoff from storms up to a 10-year frequency and the "secondary system" which is capable of carrying runoff from storms up to a 100-year frequency without causing serious damage to adjacent properties must be identified and planned during the preliminary planning stages of a proposed development. The "primary system" and "secondary system" for drainage are viewed as two separate and distinct sub-systems.

All retention and detention facilities must have sufficient capacity to detain the excess runoff from a 100-year storm. Permanent easements for surface drainage and stormwater retention/detention must be provided.

Natural drainage ways should be used for conveying storm runoff whenever possible. The Plan notes the importance of natural drainage for improving water quality and minimizing the increase in the amount and rate of runoff generated. When new drains are required, the use of open channel drains is encouraged. Open channel drains should be designed to avoid excessive velocities and erosion problems, and should have a natural appearance.

The "blue-green development concept" is defined as the use of selected portions of the site for the temporary detention of stormwater. "Blue-green" facilities are separate from retention/detention facilities. They may be either "green" when there is no standing water, or "blue" when there is permanent water. "Blue" areas must meet design standards for retention and detention basins.

The use of roadside ditches in low density developments for conveyance of storm runoff is an additional plan policy. As noted in the Plan, "roadside ditches will improve the quality and minimize the increase in the amount and rate of stormwater discharged from the area."

Permanent surface drainage easements are required over the 100-year floodplain of all major drainage courses. Easements must prohibit any activities which would substantially alter the "natural state" of the floodplain. Easements are also required over the 100-year floodplain of all retention/detention basins, and over overland flow routes of the secondary drainage system which are not within the public right-of-way.

Design requirements detail engineering standards for retention/detention facilities, the primary and secondary drainage systems, and floodplains. Each retention and detention facility must have two outlets: a primary outlet for discharging flows up to a 10-year storm, and a secondary outlet for discharging flows up to a 100-year storm (at a rate not to exceed the existing peak flow).

When the "blue-green detention area" concept is used or when natural swales and depressions are used for stormwater detention, the total volume of runoff which must be retained in basins may be reduced. This approach recognizes the function and value of natural areas for stormwater detention through natural infiltrations.

The Storm Water Management Plan is based on the premise that significant runoff from development can be controlled through the site plan and subdivision plat review process. It is not anticipated that a system of storm drains through the township will be necessary.

Regulatory Programs

The adopted Storm Water Management Plan serves the purpose of engineering design standards. Although the Plan provides the technical basis for the regulation of new developments and stormwater management, the Plan is not considered by the township to be the regulations.

Several ordinances and review requirements of Oakland Township supplement the Storm Water Management Plan by directing development in a way which is compatible with the Township's resources. The most important elements of the Township's regulatory program for stormwater control purposes include:

- Environmental Assessment requirements;
- Grading plan review requirements (as specified in the Subdivision Control Ordinance)
- Floodplain and wetlands permit requirements

In addition to these regulations, Oakland Township encourages open space preservation when completing zoning reviews, site plan reviews, and subdivision plat reviews. The Township Zoning Ordinance includes a planned residential development (PRD) option which encourages cluster development and open space preservation. .

Environmental Assessment Requirements:

Site plans and subdivision plats submitted to the Township are reviewed to identify potential drainage and erosion problems. A landscape plan, a grading plan, and a drainage distribution plan are components of each site plan. An environmental assessment must be prepared for each development proposal. The intent of the environmental assessment is to inject into the developer's planning process consideration of the characteristics of the land and the interests of the entire community. The complexity of the analysis must reflect the magnitude of the project, and is not intended to create a burden to the developer. The impact of the project on the natural drainage system is one specific requirement.

Grading Plan Review Requirements:

The Oakland Township Subdivision Control Ordinance specifies that the storm drainage system must be installed in accordance with plans approved by the Township engineer. When county drains are involved, a letter or document of approval from the Oakland County Drain Commissioner must be submitted. Adequate and safe disposal of rearyard storm drainage must be provided, as described by the Township engineer. Grading must be carried out in accordance with requirements of the Erosion and Sedimentation Control Act and permit requirements of the Oakland County Drain Commissioner.

The subdivision control ordinance specifies grading plan requirements. The grading plan must clearly show areas to be cleared or disturbed during grading and construction. After the grading plan is approved by the Township, the developer's engineer must set sufficient stakes in the field to clearly indicate the areas of the site which are not to be disturbed. A pre-construction meeting between the Township engineer, the developer's representative, and the developer's engineer is required to determine the work schedule and to assure that all parties are in agreement on the areas of the site that are to be preserved in their natural state. Prior to the start of any clearing and grading, the developer must deposit with the Township sufficient funds to cover the cost of inspection of the work by the Township engineer. A cash bond or other assurances of performance in the amount to be determined by the Township is required to guarantee that the clearing and grading will conform with approved plans. The contractor must notify the Township at least two days prior to the initiation of the project. Similar provisions apply to site plan reviews.

Floodplain and Wetland Permit Requirements:

Oakland Township's Flood Plain and Wetlands Ordinance provides for the protection, preservation, proper maintenance, and use of Township watercourses and wetlands in order to minimize disturbance to them and to prevent damage from erosion, turbidity or siltation, a loss of fish or other beneficial aquatic organisms, a loss of wildlife and vegetation, and natural habitat destruction. Water supply protection, water pollution protection, and safety from flood hazards are additional purposes. The Ordinance requires the preparation of a master drainage plan showing wetlands, watercourses, floodplains, and floodways.

Construction or extension of drainage facilities (open or closed) and discharge to any lake, pond, stream or watercourse requires that a satisfactory method be provided for the proper management of pollutants. Permits are required to deposit any materials (including structures) or remove any material from floodplains, watercourses, or wetland areas. In reviewing permit applications, the Planning Commission and Township Board consider the probable effect of the proposed activity on water quality, fish or wildlife, adjoining wetlands and drainage areas, the ability of the resource to store water as well as the conveyance and replenishment functions, erosion control, inundation upstream and downstream, groundwater, and other factors. Reflecting requirements of the Michigan Environmental Protection Act, no approval is given if the action is, or is likely, to pollute, impair or destroy a wetland, floodplain, or watercourse unless there are no feasible and prudent alternatives and unless the approval is consistent with the public interest. If approval is granted, the Township Board may establish reasonable conditions including performance bond requirements.

Development Review Fees:

Oakland Township charges landowners for the cost of technical reviews for site plans and subdivision plats. For example, a review of the pre-preliminary plat, tentative preliminary plat, final preliminary plat, and final plat costs a total of $75.00/lot. Separate fees are charged for the review of plans for physical improvements. For example, subdivision grading review fees are $5.00 per lot, and stormwater detention or retention systems are $200.00 each.

Additional fees are charged for on-site inspections. A fee of $140.00 per crew day is charged for each member of the construction review staff assigned to the work. In most cases, a deposit is required prior to construction. The deposit is used to pay the inspection fees and the balance is returned to the landowner when the project is complete. The deposit helps to ensure that construction is carried out in accordance with approved plans.

Operation and Maintenance Programs

Oakland Township does not presently own or maintain storm drains or stormwater retention facilities. The recent adoption of the Storm Water Management Plan, however, has defined the Township's policy concerning maintenance of new retention and detention facilities: such as maintenance will be the responsibility of the Township. Storm drain maintenance will remain the responsibility of the Oakland County Drain Commissioner, the Oakland County Road Commission, or private owners. Oakland Township will assist with storm drain maintenance, if needed.

Through the review of development proposals, the Township encourages the use of natural areas, such as swales, small ponds, and wetlands, for stormwater retention areas. When natural areas are used, maintenance needs are substantially reduced. Possible maintenance activities in stormwater management areas include removal of brush or removal of silt.

PART III: INNOVATIVE APPROACHES TO STORMWATER MANAGEMENT

Erosion and Sedimentation Control Activities

Although Oakland Township is not a charter township and is not allowed under provisions of the Michigan Erosion and Sedimentation Control Act to administer the erosion permit requirements, the Township takes an active role in controlling erosion.

Whenever development plans (including plot plans for single-family homes) are reviewed, the effect of the development on soil erosion is identified. Oakland Township Planning Commission, and Township Board only approve development plans which minimize land disturbance and erosion potential.

The heart of the erosion control activities in Oakland Township is in the area of inspection and enforcement. Through experience, the Township learned that approved development plans can easily be misinterpreted by contractors working in the field. To ensure that all parties understand the requirements, a "pre-construction conference" is held involving the Township engineer, the developer's representative, and the developer's engineer.

Oakland Township then maintains an active inspection program during construction. Although enforcement of erosion permit requirements are the responsibility of the Oakland County Drain Commissioner, Oakland Township believes that erosion can only be controlled through on-site inspections at a frequent interval. The Township views erosion control as their responsibility under their zoning and subdivision regulation authority.

Regulation of Large Acreage Land Division with Private Roads

Oakland Township encourages private road developments with large acreage land development with private roads which provide for the protection of open spaces, wetlands, natural stormwater retention areas, and other natural features. The Township regulates large lot developments through the Land Division Ordinance.

Michigan's Subdivision Control Act (Act 288, P.A. of 1967) defines subdivision as the act of land division creating five or more parcels, each of which is 10 acres or less in area. The division of land into four parcels or division into parcels larger than ten or more acres each, however, is not subject to the requirements of the Subdivision Control Act. The use of the Land Division Ordinance allows Oakland Township to encourage development which complements the rural character of the community. In contrast, subdivision plat requirements often lead to an urban appearance, with curb and gutter and other urban amenities.

Cost savings provide a substantial incentive to land developers to follow the Land Division Ordinance and use large acreages and private roads. Although fewer lots are created, improvements such as curbs and gutters are not required. This approach helps to protect open space, wetlands, and natural stormwater retention areas. The large acreage program helps make the Storm Water Management Plan a realty.

For Further Information:

Mr. Alfred J. Taylor, Supervisor
Oakland Township
4393 Collins Road
Rochester, MI 48063

Mr. Charles Biegun, Consulting Engineer
Giffels-Webster Engineers, Inc.
2731 Adams Road
Pontiac, MI 48057
(313) 852-3100

Ms. Carolyn Phelps, Town Clerk
Oakland Township
4393 Collins Road
Rochester, MI 48063
(313) 651-4440

PITTSFIELD TOWNSHIP

STORMWATER MANAGEMENT CASE STUDY

PART I: INTRODUCTION

Community Characteristics

Pittsfield Township is a rapidly growing township in the Ann Arbor, Ypsilanti, and Saline metropolitan area (located south and east of the City of Ann Arbor). Proximity to the City of Ann Arbor and the University of Michigan, as well as I-94 have stimulated the demand for urban land uses. Between 1970 and 1980, the Township grew from a population of 8,000 to 12,500 persons. In addition to single-family and multiple-family dwelling units, a number of small industrial and commercial operations have been constructed in the past decade.

The Township can be divided into two sections: the urban area, primarily located just to the south and east of Ann Arbor, and the rural area further south. The Township is a charter township and prides itself on its approach to services and financing policies. When public services are needed or requested by residents, they must be financed by persons receiving benefits from the services.

Pittsfield Township is nearly equally divided into areas which are part of three river basins: the Huron River basin, the Stony Creek basin, and the Saline River basin. Small natural creeks and wetlands are found throughout the Township. Several major open ditch drains have been constructed by the Washtenaw County Drain Commissioner. Several developed areas have enclosed storm sewer pipes, or have small pipe systems which discharge into natural drainageways. Because the topography is realtively flat, rainwater often pools in lowland areas for long periods of time.

The urban area of the Township receives municipal sewer and water services through contract arrangements with Ypsilanti Township and the City of Ann Arbor. Pittsfield Township owns and operates its own water distribution and sewer collection systems and has recently embarked on an ambitious construction program significantly expanding the potential urban area.

Preceding page blank

Stormwater Management Philosophy

The Pittsfield Township Board became concerned about stormwater management in the late 1960's when urban development began to accelerate. Although the Township was substantially undeveloped at the time, the Board wanted to take appropriate preventive actions to avoid potential flooding problems and to help protect water quality within the Township as well as in downstream communities. Most importantly, the Township was concerned that a lack of stormwater management when the community was relatively rural could create severe financial problems in future years. As a result of these factors, a stormwater philosophy which regards stormwater management as equally important to water and sewer services evolved.

Stormwater management is one of a number of elements of proposed site plans and subdivision plats which are reviewed by Pittsfield Township. The stormwater management philosophy of Pittsfield is to avoid flooding and the need for expensive drain improvements through the review and approval process. Stormwater drainage from individual residential lots (not subject to a subdivision plat review) is not regulated.

Stormwater Management Program Overview

The major emphasis of the Pittsfield Township stormwater management program is the review and approval of plans before development takes place. All developments which are subject to approval by the planning commission must provide for the temporary retention of stormwater runoff for a volume equivalent to a 100-year 12-hour duration storm. Discharge from the site must be properly controlled.

Pittsfield is concerned about the maintenance of retention basins and encourages the design of low-maintenance facilities. Facility maintenance is considered to be the responsibility of the Washtenaw County Drain Commissioner through the establishment of drainage districts -- the Township does not assume maintenance responsibilities. Pittsfield coordinates large stormwater improvements with the Drain Commissioner to ensure that they are acceptable to the Drain Commissioner for maintenance purposes.

As a means of facilitating the best possible approach to retention of stormwater, Pittsfield encourages adjoining landowners to jointly provide areawide retention facilities in appropriate cases. In addition, the Township has taken the lead in coordinating administrative and financial activities of several government agencies in order to provide stormwater pipes and related facilities.

The sections below describe Pittsfield's approach to stormwater planning, regulation, and maintenance. Pittsfield's approach to areawide retention/detention and inter-agency facility financing are described in the concluding section of this paper.

PART II: STORMWATER MANAGEMENT PROGRAM DESCRIPTION

Planning Program

Pittsfield Township does not have a specific stormwater management planning program. However, the Township's Comprehensive Plan, adopted in 1975, includes a section pertaining to storm drainage.

The Comprehensive Plan emphasizes the importance of proper storm drainage, and identifies criteria for the review and approval of development plans (such as retention for a 100-year 12-hour duration storm). The importance of coordinating the development of all utilities -- sewer, water, and stormwater -- is also emphasized. Storm drain improvements are viewed as a utility which is equally important as municipal sanitary sewer and water services.

The plan identifies a planning approach to stormwater detention. Noting the flat topography of much of the Township, the plan recommends the use of lowland areas as detention basins during periods of extreme rainfall. Such areas could be purchased by the Township and used for recreational purposes. Multiple use of stormwater retention areas is facilitated in Pittsfield, because the natural drainage system (including isolated lowland areas) is adjacent to proposed parks and open space areas. The township also requires that such areas be preserved in their natural state, without public purchase, as part of plat or site plan review.

In addition to flood prevention, stormwater management for groundwater recharge purposes is stressed for the rural areas. As stated in the plan, aquifer recharge in Pittsfield Township is particularly important because many rural area wells are shallow and do not penetrate bedrock or bedrock channels.

The relationship of open space preservation and stormwater management is recognized in the plan. The adopted open space strategy is to permanently preserve all areas with important ecological value (including wooded areas, wetlands, and natural wildlife habitats) through public purchase or private reservation for some type of open space use. It is the policy of the Township to acquire one acre of park land for every 100 persons of resident population. The plan coordinates the open space system with the storm drainage system to provide natural water storage areas and to utilize natural creek corridors as a means of storing and conveying stormwater to appropriate outlets.

Regulatory Programs

Pittsfield Township controls stormwater runoff from new developments in two ways: (1) through the review and approval of development plans for permanent stormwater management; and (2) through erosion and sedimentation control permit requirements.

Drainage Reviews for Development Plans:

Storm drainage engineering design standards, adopted by Pittsfield Township in 1976, provide the basis for technical requirements for new development. The Engineering Design Standards are used whenever site plans and subdivision plats are submitted. The Township's consulting engineer works with the proprietor or the proprietor's engineer to ensure that the requirements are understood.

Six specific standards pertaining to "pre-planned flooding areas" (retention or detention areas) are specified:

1. Upon improvement of all sites, capacity must be provided for the temporary retention of stormwater runoff from a 100-year 12-hour duration storm.

2. Selection methods of providing for the pre-planned flooding area include, but are not limited to, the following:

   - Deep permanent lake,

   - Landscaped shallow temporary flooding area,

   - Dished parking lot,

   - Underground storage,

   - Roof storage,

   - Combination of the above.

3. Discharge from the developed site cannot exceed the maximum rate of discharge which occurs on the undeveloped site from a 10-year rainfall. The discharge should be at the bottom of the pre-planned flooding area.

4. In cases when the drain outlet is not deep enough to completely dewater the basin, pumps must be installed.

5. Adequate protection must be given to all inlets and outlets.

6. The discharge shall be converted to sheet flow prior to reaching the property line of the development.

The type of retention facility constructed on the site is determined by the property owner, provided that the standards are met. The Township engineer and the Planning Commission, however, encourage the development of attractive facilities which are assets for the development. Retention/detention areas and drainage courses should be landscaped features which appear natural with gentle slopes and no fences.

For small commercial and industrial sites, storage of stormwater in parking lots or swales is the typical approach followed. In larger developments, dry detention basins are encouraged. Retention basins with standing water will be approved, however, if it is clear to the Township that proper maintenance will be provided by the owner. In general, the Township encourages the construction of basins which do not require extensive maintenance.

Lowlands and wetlands are used as part of the "pre-planned flooding area" when possible. Small ponds, for example, are sometimes enlarged for stormwater retention purposes. The Township, however, does not have specific wetlands protection requirements. Planned unit developments (cluster developments) which have higher densities on part of the site and open space preservation on other portions have been approved in Pittsfield Township, although the Township does not encourage any single approach. In one subdivision, the PUD (cluster development) approach helped to provide floodplain protection.

Pittsfield Township has also adopted design standards for grading and rear yard drainage. The recommended plan is drainage from the rear of the house to the rear of the lot with a minimum grade of one percent, and from the front of the house to the street with a minimum grade of one percent. These standards ensure that each lot has proper drainage.

It has been Pittsfield Township's experience that on-site inspections of retention/detention facilities during the construction phase is extremely important. Small changes in the slope of the basin bottom, for example, will affect the functioning of the basin and maintenance needs. Without frequent and careful on-site inspections, alterations in the approved engineering design plans for stormwater management could be made. Stormwater facility inspections are completed by staff and consultants at the same time that water and sewer facility inspections are made. Inspection of the facilities is required before a certificate of occupancy is issued. Although a special fund is established for each development to provide for costs associated with water and sewer facility inspection, a special stormwater facility inspection fund has not yet been established.

The cost of engineering reviews of stormwater facilities by the Township can be expensive and time consuming, especially when proprietors propose approaches which do not meet the requirements of the Township. To cover engineering review fees, the Planning Commission has adopted a fee schedule. For example, the total fees for subdivision reviews (tentative preliminary plat, final preliminary plat, and final plat) are $950.00 plus $13.00 per lot. The filing fee for a planned unit development is $1,500, plus site plan fees. Eighty percent of the planned unit development filing fee is refunded upon completion of the project as approved.

Erosion and Sedimentation Control Permits:

Pittsfield Township administers an erosion and sedimentation control ordinance, in accordance with requirements of the Michigan Soil Erosion and Sedimentation Control Act (Act 347, P.A. of 1972). A permit is required for any development one acre or more in size or a development within 500 feet of a lake or stream. Straw bales and stone filters are typically required to reduce erosion during construction.

Erosion control review is not required for parcels which are smaller than one acre. Erosion on the flat terrain within the Township is generally not a problem on small sites.

In the process of administering development review regulations, Pittsfield Township has developed some practical strategies for ensuring that the Township's standards are followed. Pittsfield provides proprietors with copies of the adopted engineering design standards. The standards are intentionally non-technical, in order to allow the proprietor to understand the requirements. The Township engineer discusses the requirements with the proprietor or the engineer involved, and will often identify alternative approaches for providing on-site retention/detention. The design of the site plan or subdivision plat, however, is the responsibility of the proprietor. A series of meetings to discuss and negotiate the interaction of all phases of development are then held, resulting in the final design and approval by the Township.

Facility Maintenance Program

Pittsfield does not directly perform maintenance on storm drains or retention/detention facilities. Maintenance is generally considered to be the responsibility of the property owner. When a subdivision plat or large development is proposed, the Township encourages the landowner to make arrangements with the Washtenaw County Drain Commissioner for maintenance.

If the Drain Commissioner agrees to accept responsibility for maintenance following the construction of a retention/detention basin, a Chapter 4 drainage district is established and district property owners are assessed charges for the maintenance. Chapter 4 of the Michigan Drain Code outlines specific procedural requirements for establishment of drainage districts. A petition must be submitted by one-half of the landowners in the proposed drainage district to initiate the involvement of the Drain Commissioner.

Pittsfield Township tries to avoid the construction of facilities which require extensive maintenance. The Township has occasionally notified owners of improper maintenance of drainage facilities although a formal inspection program is not conducted.

PART III: INNOVATIVE APPROACHES TO STORMWATER MANAGEMENT

Stormwater Retention Areas Serving Multiple Properties

In order to most effectively use land resources and existing lowlands and depressions, Pittsfield Township has identified the need to establish stormwater retention/detention areas serving several individual properties. Although not an officially adopted policy, this approach is preferred because it provides the potential for using retention/detention areas for recreation and open space purposes, and reduces problems related to providing facilities on small sites.

In effect, the Township engineer has a "plan" envisioned for several community retention/detention areas. The plan is implemented to a degree whenever a property in the particular drainage basin is subject to development plan review and approval.

The Barron Professional Building property offers one example of how Pittsfield Township encourages community retention/detention facilities. The Barron property is a dry, upland area which historically has drained into a low, swampy area nearby. The Township engineer identified the adjacent swampy area as a site with potential for development as a community retention/detention area.

When the Barron Professional Building site plan was submitted for Township review, Pittsfield required the owner to provide positive drainage on his property and to obtain drainage easements on other properties leading to the natural retention area. When other adjacent parcels are developed, they will be required to continue the improvement. In effect, this scheme continues the existing use of the lowland area for natural detention. According to Township policy, the downstream property owner is always responsible for natural, upstream drainage. Since an enlargement of the swampy area should not be necessary, special compensation for the owner of the natural detention site will not be needed.

Multiple-Agency Financing for Stormwater Facilities

Pittsfield Township takes the lead, when necessary, in inter-agency negotiations in order to secure appropriate funding for stormwater facilities. The example presented here concerns storm drain financing. The approach could be used, however, to finance community retention facilities as well.

The Washtenaw Clubview Subdivision was platted in the 1920's, and only partially developed until the 1960's when municipal sewer and water facilities became available. With the provision of water and sewer services, "infilling" of vacant lots began to occur. Because the area is generally flat, the undeveloped lots were often subject to flooding. As the development occurred, the township took a lead role in developing a solution to the drainage problem.

In the later 1960's, a preliminary engineering study identified locations and costs for storm sewers to alleviate the flooding problems. The costs of the project, however, were prohibitive.

An opportunity to partially readdress the problem was presented To the township in the mid 1970's when a developer proposed to complete development of the Washtenaw Clubview Subdivision. Pittsfield Township required the provision of storm sewer facilities as a condition for approval. Since a collector storm sewer linking the new development area with the main storm drain would pass through the developed area with flooding problems, the Township required the developer to provide additional capacity. A fee of $20,000 was paid to the developer for providing the extra capacity in the collector storm sewer. The general fund was used to pay for the additional capacity. This approach to providing collector storm sewers in the developed area subject to flooding was used on two occasions.

Since construction costs for a project serving the flood-prone area were now reduced to a reasonable level, a Chapter 4 drain construction project sponsored by the Washtenaw County Drain Commissioner was proposed. Bonds on the project were not sold before the Headlee amendment became effective in 1978. As a result, project financing had to be revised.

The revised approach to the Clubview Subdivision improvements involved financing from Pittsfield Township, the Washtenaw County Road Commission, and the establishment of a Chapter 4 drainage district. It was agreed that Pittsfield Township (using general funds) would pay for 30 percent of the project, that the Road Commission would fund 33 percent, and that the remainder would be assessed to property owners within the subdivision through the Chapter 4 drainage district. This financial package provided for the construction of storm sewers.

This case example illustrates the difficulty of remedying stormwater management problems after development has occurred. The original plat did not provide for stormwater drainage. If the subdivision had been developed in the 1970's with the use of the Township's retention standards, the flooding problems would have been avoided. The use of some Township funds to contribute to the financial package was necessary, although Pittsfield Township believes in the user charge principle -- namely, that benefited property owners should pay for utility improvements.

For Further Information:

Mr. Robert Lillie, Supervisor
Charter Township of Pittsfield
701 W. Ellsworth Road
Ann Arbor, MI 48104
(313) 996-3000

Mr. Roger Gaugler, Township Engineer
Charter Township of Pittsfield
701 W. Ellsworth Road
Ann Arbor, MI 48104
(313) 996-3000

CITY OF STERLING HEIGHTS

STORMWATER MANAGEMENT CASE STUDY

PART I: INTRODUCTION

Community Characteristics

The City of Sterling Heights is a rapidly developing suburban city in southern Macomb County. The City was formed from Sterling Township in 1968 and spans 36.8 square miles. The growth of the area was spurred by automotive and other manufacturing firms which constructed plants in the 1950's. Since then, strong growth in the residential, commercial, and industrial sectors has continued.

Between 1970 and 1980, the population increased from 61,400 persons to an estimated 108,900. In 1970, only 35 to 40 percent of the land area of the City was developed. By 1980, approximately 60 to 65 percent of the City was developed. Residential development has been balanced with commercial and industrial development in the decade of the 1970's. Municipal water and sanitary sewerage services from the City of Detroit regional facilities are available throughout Sterling Heights.

Sterling Heights is located in the downstream reaches of the Clinton River basin. Runoff from many other communities in Macomb and Oakland counties flows through Sterling Heights before it reaches Lake St. Clair. Stormwater runoff originating in Sterling Heights flows through a local system of improved and unimproved storm drains which outlet in the Clinton River, the Red Run Drain, Big Beaver Creek, Plum Brook Creek, or the Utica Drain. The Clinton River and the Red Run Drain are major waterways capable of handling significant volumes of water. The topography of Sterling Heights is predominantly flat. Clay soils throughout much of the City preclude natural infiltration of significant quantities of stormwater.

Stormwater Management Philosophy

City of Sterling Heights officials consider stormwater management to be a public service similar to water and sanitary sewers -- it is essential for the livability of the City today and makes future development and growth possible. Reflecting this philosophy, the City has developed programs for storm drain planning, construction financing, regulation of development, and maintenance of stormwater facilities over the past decade.

When Sterling Township became Sterling Heights in 1968, City officials were faced with decisions on proposed storm drain projects to alleviate flooding problems. City approval was needed before the Macomb County Public Works

Commissioner could construct the drain improvements. At that point, city officials realized that a comprehensive, planned approach to stormwater management was needed. Stormwater retention/detention requirements were adopted to reduce local and downstream flooding problems and a master storm drain plan initiated.

Until recently, stormwater retention/detention facilities have been viewed as temporary measures. Retention and detention facilities have been required in three of the major drainage districts (Plum Brook, Big Beaver, and Utica) because the receiving streams are not capable of handling sizable quantities of stormwater runoff. If proposed improvements to these creeks and drains are made, however, the city will no longer require retention. Unlike upstream communities, Sterling Heights must carefully consider the timing of stormwater flow peaks from upstream. In order to minimize peaks (which reach Sterling Heights 12 to 24 hours after a major storm event) the direct discharge of stormwater without retention or detention is preferred.

The enactment of the Headlee amendment, requiring public approval of proposed bond issues makes the ability of Sterling Heights to construct major drains in the future extremely uncertain. As a result, the City is now regarding retention and detention basins as permanent, and different design approaches are being considered. The construction of a series of large, areawide retention/detention facilities serving several developments (as large as 20 acres in size) is seen as a useful retention/detention facility design strategy. The areawide retention facilities would be a substitute for a number of small retention/detention basins (quarter-acre in size). Financial, aesthetics, and maintenance considerations underline the need for providing retention/detention facilities on an areawide basis.

In summary, Sterling Heights has actively managed stormwater runoff for the past 12 years. Whereas the program initially emphasizes storm drain construction as the solution, a combination of storm drains and retention facilities is the emerging trend. The city has taken a strong and consistent approach to retention/detention requirements when new developments are proposed. It is recognized that the use of retention requirements before development pressures came has been a key to the City's success in implementing the requirements.

Stormwater Management Program Overview

The major components of Sterling Heights' stormwater management program include the Master Drain Plan (completed in 1971), "Standard Design Details" which are used as engineering standards when development plans are reviewed, inspection and maintenance program for retention basins and storm drains, and facility construction operations. Zoning ordinance requirements related to the use of floodplain areas play a major part in the stormwater management program.

Innovative aspects of the City's program which are emphasized in this report include:

- Coordination of stormwater management with recreation facility planning; and
- Retention basin inspection and maintenance program.

Stormwater management activities and programs carried out by the City of Sterling Heights are summarized in the sections which follow. Innovative programs are highlighted in Part III of this report.

PART II: STORMWATER MANAGEMENT PROGRAM DESCRIPTION

Planning Program

The City's Master Drain Plan is one of a series of elements of the Master Development Plan. The intent of the planning effort, initiated in 1969 soon after the City of Sterling Heights incorporated, was to provide a comprehensive view of future storm drain facilities. The City needed a plan which would provide an overview of major future drain projects, including costs.

The Plan consists of a written report and a map delineating drainage districts, existing drainageways, and proposed drains. The proposed storm drain system is designed to contain runoff from a 10-year frequency storm. The extent and type of development indicated on the City's master land use map was used in making runoff calculation/detentions. As each drainage district reaches the stage of development reflected on the master land use map, the drain for the district will be fully utilized. Districts, routes, types of drain (open or closed), sizes, and hydraulic gradient elevations have been determined in the Plan. The Plan, however, is not a substitute for detailed engineering studies.

Stormwater flows carried through Sterling Heights by the major waterways as well as effects of Sterling Heights' stormwater on downstream communities were carefully considered in the planning effort as amendments to the Master Drain Plan. Since Sterling Heights receives upstream peak flows after storms from from 23 to 24 hours after the storm event, retention is not a component of the plan.

The City's current efforts to develop large-scale retention/detention facilities serving several developments are not reflected in a comprehensive plan. Instead, the City intends to present proposals for large-scale retention/detention facilities to the City Council for approval on an individual basis as amendments to the Master Drain Plan. Approximately 12 to 14 locations where large-scale basins could be used, however, have been identified by City staff.

Regulatory Program

Components of the city's stormwater regulations include the following:

- "Standard Details" for retention basins;
- Floodplain area requirements (zoning ordinance); and
- Erosion and Sedimentation Control Ordinance.

Sterling Heights has a planned unit development (PUD) option in the Zoning Ordinance which encourages the protection of open spaces on the site, among other purposes. This design option, however, has never been used. Because of the extensive areas of clay soil in Sterling Heights, open space preservation to maximize natural infiltration of stormwater is not an approach followed.

"Standard Details" for Retention Basins:

"Standard Details" for retention/detention basins provide a basis for the review and approval of site plans and subdivision plats by the City of Stering Heights. The City's Subdivision Ordinance requires approval of proposed stormwater facilities by the City engineer. Site plan review is authorized by the Zoning Ordinance.

If the existing storm outlet is adequate, the engineering department requires on-site retention/detention. Generally, the retention must provide capacity equivalent to two inches over the entire developed site and restrict the outflow to 0.1 cfs/acre.

When sites are two acres or less in size, the use of parking lots and other paved areas with restricted outlets and/or catch basin covers is permitted. A retention or detention basin designed in accordance with the "Standard Details" is generally required for sites larger than two acres.

Reflecting the size of the receiving stream (outlet), on-site retention/detention is required in the following drainage districts:

- Beaver Creek
- Plum Brook Creek
- Utica Drain

On-site retention/detention for projects within the Red Run Sterling Relief Drain and Clinton River drainage areas is not required, providing that the connecting offsite receiving stream is adequate.

"Standard Details" for dry detention basins are for fenced basins with a maximum side slope of 4 on 1. All inlet and outlet pipes must have bar screens and grouted rip-rap. The entire basin within the fencing must be seeded and mulched or sodded. Contractors are responsible for dewatering of the basin until such time that the basins are accepted by the City.

Basin bottoms must have a slope of 1 percent with underdrains capable of handling the dry-weather flow between inlet and outlet. Basins with pumped outlets must have duplicate pumps with 3-phase motors. Because of the City's flat terrain, pumps are necessary in many cases.

Due to the topography and soils of Sterling Heights, few landscaped lakes and other basins with "natural" appearances have been proposed. Many of the basins proposed are dry, fenced basins, as reflected by the "Standard Details."

In the review of proposed basins, Sterling Heights makes sure that the area of the basin can be re-used in a way compatible with existing zoning if it should be abandoned in the future. For example, in a residential subdivision, the City makes sure that the retention basin is located in an area which could be developed as homes. Without such efforts, future pressures for spot commercial zoning or other incompatible uses might result.

Site plan review fees for engineering and planning departments are as follows:

- Plan review -- $200 minimum plus $40 per acre for each additional acre or fraction thereof over the first acre.
- 1.2 percent of the estimated cost of all improvements that are to be owned, operated and maintained by the city.

Prior to the initiation of stormwater facility construction, and inspection escrow deposit must be made to cover anticipated inspection costs, including stormwater facility inspection costs. At the completion of construction, unused monies are refunded.

Floodplain Area Requirements:

Floodplain requirements in Sterling Heights exceed requirements for the federal Flood Insurance Program and, in effect, prohibit development in the floodplain. As stated in the City's Zoning Ordinance, the "floodplain area provisions are intended to protect the floodplain of the Clinton River branches and tributaries, so that the reservoir capacity shall not be reduced, thereby creating a danger to areas previously not so endangered in time of high water, nor to impede, retard, accelerate or change the direction of the flow of water or carrying capacity of the river valley or to otherwise increase the possibility of flood."

Designated floodplains are restricted so as to prohibit places of residence or employment. Recreation areas, land balancing, parking areas, utilities, and other specified uses are permitted if they meet the standards and requirements of Sterling Heights.

The City's Subdivision Ordinance also includes provisions for floodplain protection.

The overall direction of the City's floodplain management efforts is to protect the Clinton River floodplain as a public recreation and natural area. It is the intent of the City to prohibit development in floodplains of tributaries leading into the Clinton River and the Red Run drain as well. When (and if) storm drain improvements are made along these tributaries, most of the right-of-way will be unencumbered and available for use.

Erosion and Sedimentation Control Ordinance:

The City administers and enforces its Erosion and Sedimentation Control Ordinance in accordance with provisions of the Michigan Soil Erosion and Sedimentation Control Act (Act 347, P.A. of 1972). Permits are required for developments larger than one acre in size or within 500 feet of a lake or stream.

Typical measures required to control erosion during construction include filters, vegetative cover, berms, and ponds. Siltation ponds and basins are not used for long-term retention because outlets get plugged during construction and the assessment of costs for clean-out of the basins when construction is completed is difficult to enforce.

The following guidelines are highlighted in the City's booklet on "Site Plan Requirements":

- All earth changes shall be designed, constructed, and completed in such a manner to limit the exposed area of disturbed land for the shortest possible time.

- Any temporary or permanent facility designed and constructed for the conveyance of water around, through, or from the earth change area should be designed to limit flow to a non-erosive velocity.

The soil erosion and sedimentation control plan submitted with the permit application must show the timing of the development, locations of structures and natural features within 50 feet of the site, proposed grading, and plans of all drainage provisions, among other information.

The minimum soil erosion permit fee is $50.00. For sizable projects, the fee is as follows:

- 1/4 of 1 percent of earth disrupting costs of the first $500,000

- 1/8 of 1 percent of earth disrupting costs in excess of $500,000

Earth disrupting costs include installation of sanitary and storm sewers, water mains, paving, parking lots, grading, stripping, site preparation and access roads. An additional deposit to pay for erosion and sedimentation control inspections is also required.

Operations and Maintenance Programs

Since 1968, Sterling Heights has been actively involved with the construction of major storm drains to alleviate potential flooding conditions in the City and downstream. The role of the City has been to identify priority projects and obtain financing. Actual construction work is typically performed by the Macomb County public works commissioner, using the authority of Chapter 20 of the Michigan Drain Code.

To pay for the cost of storm drain improvements, a special levy of 1.7 mills city-wide has been charged each year since the late 1960's. The levy continues without review through a referendum provided that the level remains the same. At present, $1 million of the revenue generated each year is used to retire bonds previously issued. The reminaing $700,000 is used for new storm drain construction.

To date, the City has not constructed retention facilities. However, several basins or lakes to serve a number of property owners are being planned. If retention facilities are required on a permanent basis, the City will propose a series of large basins or lakes to replace the small basins (which are relatively unattractive) scattered throughout the City.

For example, a 20-acre retention lake is proposed in the northwest area of the City adjacent to the new Joseph J. Delia Northwest Park Manor proposed for development in the near future. The City is working with developers in two adjoining areas to design the lake which will meet retention requirements for the two developments. In addition to stormwater retention, the lake will be a recreational asset with public access through the new park. A financing and design plan will be submitted to the City Council for approval.

Approximately 60 retention and detention basins are now located in Sterling Heights. Approximately one-third are maintained by the Macomb County Public Works Commissioner (basins built prior to 1969), approximately one-third are privately owned and maintained, and the remaining one-third are owned and maintained by the City.

Maintenance work carried out by Sterling Heights includes fence repair, concrete work, debris cleanup, grass cutting, and bank stabilization. In the future, removal of sediment from basins is anticipated. The City requires landowners to pay for 15 years of basin maintenance. Although fees are widely varied because of different basin maintenance costs, they typically range from $10,000 to $30,000 (lump sum payment made after construction). It is the policy of Sterling Heights to contract maintenance activities to private firms whenever possible.

If the proprietor will live or will occupy the development site, ownership and maintenance of retention basins by the proprietor may be permitted. In such cases, the City enters into an agreement with the proprietor which sets forth maintenance responsibilities. The following requirements are included in the agreement:

- The proprietor must convey to the City easements and rights-of-way necessary for inspection.
- The proprietor agrees to maintain the basin, fencing, pumps, etc. and to provide a minimum of one mowing a month between May 15 and October 15 each year, and to keep the reservoir clear of all dirt, debris, trash, etc. and to maintain it in a safe, attractive manner. The proprietor must provide the name, address and telephone of the person or company responsible for maintenance.
- If the proprietor fails to maintain the stormwater drainage construction and improvement, fencing, pumps, etc., notice will be given by the City.

> If the failure is not corrected within ten days, the City shall correct the failure (or have it corrected). Charges would then be made to the proprietor.

The Sterling Heights Department of Public Works makes routine inspections of all retention and detention basins in the City, including privately owned and maintained facilities. At the time of project approval, funds must be contributed by the proprietor to pay for the inspection. The charge is $5.00/week/basin for a 15-year period ($3,900). It has been the experience of the City that without effective inspections, maintenance tasks will not be performed. If maintenance is not properly conducted, the appearance and functioning of the basin as a stormwater control facility are threatened.

Sterling Heights also maintains some storm drains and related facilities. For example, the City attempts to remove debris from catch basin sumps once every four years. This type of maintenance activity is financed through general revenues.

PART III: INNOVATIVE APPROACHES TO STORMWATER MANAGEMENT

Coordination of Stormwater Management with Recreation Facility Planning

Sterling Heights officials have consciously tried to coordinate stormwater management objectives and projects with recreation needs and projects. For example, the protection of the Clinton River floodplain will provide important floodwater and stormwater protection. The public lands acquisition effort in Clinton River floodplain is also serving to provide an important focal point in the City and a recreational center.

The City's Master Recreation Plan presents the concept of city parks linked together by pathways (jogging/bicyle trails) along the drains. The drain right-of-way provides a stormwater conveyance corridor (with drain improvements proposed) as well as publicly owned land with a potential for recreational use. The implementation of this concept is presently being explored.

In its efforts to consolidate small retention and detention basins into larger community facilities, the City is also investigating recreational opportunities. As previously noted, one retention lake now in the planning stage will be located adjacent to a city park and will be used by city residents for fishing and boating.

Finally, through the review and approval process for retention basins in individual developments, the City attempts to locate the basins so that they can be attached to parkland when (and if) they are eventually abandoned.

At a recent goal-setting session of the City Council, officials articulated their view of the "future" Sterling Heights: a pleasant residential community with ample open spaces. Through the coordination of stormwater management projects with recreation plans, the City is implementing this concept.

Retention Basin Inspection Program

The retention/detention basin inspection program carried out by the Department of Public Works is believed to be the only program of its kind in southeast Michigan. It is an example and perhaps a model, however, for programs in other communities.

The Sterling Heights program provides for the regular (weekly) inspection of privately owned and maintained retention basins. The oversight by the City helps to ensure that basins are as attractive as possible and function properly. Costs for the program are paid by individual landowners ($5/week for a 15-year period must be deposited with the City). Actual maintenance is carried out by the private landowners or the City.

The specific maintenance responsibilities enumerated in the retention basin maintenance agreements which are signed by landowners are also of note. The maintenance agreements clearly indicate responsibilities which extend beyond grass cutting and debris removal to include operation of pumps, silt removal, and safety.

For Further Information:

Mr. Anthony Dobry
Mayor
40555 Utica Road
Sterling Heights, MI 48078
(313) 977-6100

Mr. Ray Filipchuk
Director of Public Services
40555 Utica Road
Sterling Heights, MI 48078
(313) 977-6222

Mr. Richard Schoenherr
Director of Planning
City of Sterling Heights
40555 Utica Road
Sterling Heights, MI 48078
(313) 977-6112

Mr. Jerry Hammond
City Engineer
City of Sterling Heights
40555 Utica Road
Sterling Heights, MI 48078
(313) 977-6222

CITY OF TROY

STORMWATER MANAGEMENT CASE STUDY

PART I: INTRODUCTION

Community Characteristics

The City of Troy is a rapidly growing suburban community in southeast Oakland County. The City is large in size, spanning 33-1/2 geographic miles. A number of national corporations have headquarters in Troy and the city is readily accessible to downtown Detroit via I-75. These two factors have contributed significantly to the population growth which increased from 39,400 persons in 1970 to an estimated 67,000 in 1980. Commercial, industrial, and office development as well as middle-upper income single-family home developments have been strong in the 1970's.

Branches of the River Rouge and the Clinton River have their origin in Troy. Approximately 80 percent of the City's land area is within the Clinton River basin and contributes stormwater to the Red Run branch of the Clinton River which joins the main stem of the Clinton and flows into Lake St. Clair. Although the northwest section of the city is characterized by rolling hills, most of the city is flat and subject to localized flooding problems.

Municipal water and sanitary sewer services (from the City of Detroit) are available in most areas of Troy. Small areas, however, utilize private septic systems. A major enclosed storm drain system serves approximately 50 percent of the land area of the city. An estimated 65 percent of the land area of the city is developed. Hence, there are some developed areas which are not connected to major enclosed storm drains.

Stormwater Management Philosophy

The stormwater management philosophy of the City of Troy has gradually evolved and changed over a period of 15 years. In the mid-1960's when stormwater retention facilities were first required for major developments, the philosophy and practice of the City was to protect the city and downstream communities from flooding until enclosed storm drains could be constructed. Retention basins were initially viewed as temporary structures and little attention was paid to landscaping or maintenance aspects.

The current stormwater management philosophy of the City is that stormwater retention basins and related facilities are likely to be permanent, since storm drain improvements envisioned in the past probably will not be constructed. Retention basins, therefore, are recognized as part of the permanent stormwater flow system and strong efforts are made to ensure that the basins are attractive and easy to maintain. Reflecting the concerns of the City, the department of public works carries out a retention basin maintenance program for certain basins.

In 1964-1965, the City of Troy began requiring the retention of the equivalent of inches of stormwater over the area of the site for major new developments. The standard was not adopted in official engineering design standards, and was subsequently modified as additional technical information about stormwater retention needs became available. The city's intent in requiring on-site retention was to protect the City from lawsuits from downstream communities which in turn might lead to court-imposed development restrictions. In administering the standards, the City encouraged the completion of a hydrologic analysis indicating stormwater flows before the development and after the proposed development was completed.

The City's first engineering design standards requiring retention were adopted in 1966-1967, and required that stormwater discharge from the site be restricted to 0.1-0.2 cfs/acre, a rate which approximates stormwater runoff from most sites prior to development. The early design standards initially applied to all subdivision plats and major site plans. In the 1970's, the design standards were gradually modified to include detailed standards which apply to all development proposals -- regardless of size.

Storm drain construction programs and on-site retention requirements have been integral parts of Troy's approach to stormwater management for the past 15 years. Both storm drains and retention/detention basins are viewed as serving a particular function and together form a stormwater management system which removes stormwater in a way which avoids downstream flooding. In most areas of the City, retention/detention facilities are not viewed as an alternative to storm drains, but rather, a means of regulating the flows of stormwater into the storm drain system.

The stormwater management policies and standards of the City of Troy have been directly influenced by requirements of the U.S. Army Corps of Engineers related to the Henry Graham storm drain. The Henry Graham storm drain is a major drain connecting to the Red Run branch of the Clinton River. The drain was designed to alleviate flooding in the southeast quadrant of the city. The outlet from the Henry Graham drain to the Clinton River as originally proposed was not constructed. Instead, the Henry Graham drain connected through the Red Run branch of the Clinton River which was already receiving heavy stormwater flows from other areas of Oakland County. The City of Troy and the U.S. Army Corps of Engineers, through negotiations, agreed that the stormwater discharge from the Henry Graham drain would not exceed 800 cfs.[1] The Intercounty Drainage Board (Oakland and Macomb Counties) is responsible for maintenance on Red Run Drain improvements and monitors the implementation of the restriction.

The severe discharge restrictions on the Henry Graham drain came into effect in 1970-1971 and helped to strengthen stormater retention/detention policies in the City of Troy. Although stormwater retention is not explicitly required in the agreement with the U.S. Army Corps of Engineers, it is a logical technical method for the city to reduce local flooding and downstream flooding. According to many city officials, the City's present strong stormwater retention/detention policies were stimulated and supported by the requirements of the U.S. Army

Corps of Engineers. To provide a uniform policy for stormwater management, retention requirements have been applied throughout the city, including areas not served by the Henry Graham drain.

Some of the retention and detention basins constructed in the 1960's when retention was viewed as a "temporary" solution to stormwater management are deep, fenced pits which are unattractive and difficult to maintain. Recognizing that retention/detention basins will be permanent parts of the stormwater system in most cases, the City now encourages the construction of basins which are integral features of the development and add to its attractiveness and marketability.

Stormwater Management Program Overview

The City of Troy carries out planning, regulatory, and operations/maintenance activities related to stormwater facilities. The Master Storm Drainage Plan delineates existing and proposed storm drains (including open and enclosed facilities). Engineering design standards for new developments include specific requirements for on-site retention of stormwater and basin construction. The stormwater facility maintenance program of the City is designed to ensure that all stormwater facilities, including storm drains and retention/detention facilities owned by the City, function properly.

In addition to the basic stormwater management program of the City, several innovative projects have been carried out:

- The self-help technical assistance program for backyard drainage; and
- Construction of an in-line retention basin using general city revenues to manage stormwater from some existing and new development.

Troy's stormwater management programs are summarized below. Activities and standards related to planning, regulatory, and maintenance programs are included in Part II. Summaries of the innovative projects comprise Part III of this report.

PART II: STORMWATER MANAGEMENT PROGRAM DESCRIPTION

Planning Programs

In the later 1960's, the City of Troy adopted a drainage plan which delineates the locations of existing and proposed storm drains. Enclosed storm drains as well as permanent open watercourses are shown. The study was updated in 1975. The plan is viewed as a guide for storm drain facilities, although financial limitations are affecting the rate of construction.

Regulatory Programs

The City of Troy reviews all site plans and subdivision plats to assure that on-site retention facilities meet the City's engineering design standards. In the mid-1960's, City officials required retention of 4" of water on the site. When engineering design standards for stormwater retention were first officially adopted (1966-1967), storage of stormwater equivalent to a 10-year frequency storm with discharge at an agricultural rate (0.1-0.2 cfs/acre) was required. Since the adoption of engineering design standards, particular standards have been modified to reflect the experience of the City. For example, the City recently revised technical standards for retention/detention basin pumps in order to assure uniformity and allow for parts to be interchanged. This change will help minimize maintenance costs. In addition to proper engineering design for stormwater control, Troy is concerned about the appearance of the basins and possible safety hazards.

Engineering design standards related to retention basins, grading and rearyard drainage, and soil erosion and sedimentation control are summarized below. Regulations related to open space preservation are also referenced. Finally, requirements for environmental impact statements are noted, since these requirements help to ensure that stormwater facilities are compatible with water quality protection.

Engineering Design Standards:

Retention/detention standards are applied to all site plans and subdivision plats. Basins must be designed to store 3-1/2 inches of rain over the developed area of the site in commercial, industrial, office and high rise industrial areas. This standard is greater than volume from two consecutive 100-year frequency storms. For single family residential development, retention/detention basins must be designed to store all runoff in excess of agricultural runoff (0.1-0.2 cfs/acre).

All open retention/detention basins with side slopes steeper than one foot vertical on six feet horizontal must be fenced, except where design is an integral part of the landscape and where hazardous conditions are not created. Retention basins designed architecturally and aesthetically for a location within the development must be approved on a concept basis by the planning department before engineering review.

Earthen detention basins (designed to hold water on a temporary basis) must have a 6" perforated underdrain to ensure dewatering of the low area. Underdrains must not discharge directly into the basin outlet. Where a permanent body of water is incorporated in a retention system design, a constant source of fresh water must be provided.

The entire retention/detention basin must be seeded or sodded. The city will not accept the basin until turf is established. Concrete rip-rap is required at all pipe entrances to the basin. An overflow system must be provided with an outlet into an adequately sized storm sewer, when possible. In cases where the drain outlet for the retention/detention basin is not deep enough to completely dewater the basin, pumps must be installed. Two sets of pumps are required, with each set of pumps capable of handling the flow. Other detailed specifications pertain to fencing, the overflow system, and other features of basin design.

Because of the predominance of clay soils, the City of Troy does not encourage the use of natural infiltration as a method for stormwater control. However, as described below, the City encourages the preservation of open space areas in new developments which provide some absorption of stormwater as a supplement to "dry" or "wet" basins.

Grading plans are required for all developments and are reviewed for drainage control purposes. Rearyard drainage is required in all residential subdivisions. The City has adopted specific standards for rearyard catch basins and swales. Where topography prevents rearyard drainage from being practical, front yard drainage may be approved. Underdrains must be located in a drainage easement provided along the rear or side lot lines, as necessary. When the storm sewer is in the rear yard, the trench must be backfilled with pea gravel to the surface to act as a French drain. When the storm sewer is not in the rear yard, a perforated plastic underdrain pipe connecting to a storm sewer is required. These construction specifications provide for some infiltration of stormwater while also conveying stormwater to retention/detention facilities or storm drains.

The City of Troy has adopted an erosion and sedimentation control ordinance in accordance with the Michigan Erosion and Sedimentation Control Act (Act 347, P.A. of 1972). Typical erosion control measures required during construction include silt traps, straw bales, stone filters, and dikes. Some silt traps and vegetation may be required for permanent erosion control as well.

The City of Troy finances the technical review of site plans and subdivision plats through a design and inspection fee which is paid by each landowner. Depending on the size of the project, fees ranging from 4.7 percent to 6.1 percent of improvement costs are required.

Open Space Regulations:

The Troy Zoning Ordinance specifies an option for residential development which helps to preserve open space. The "subdivision open space plan" allows for reduction in lot sizes when at least four acres of land are dedicated for park and open space use. The Planning Commission and City Council review each open space plan proposal to ensure that the City's objectives of preserving natural features and reducing development costs (among other objectives) are met. Approximately 13 or 14 open space subdivisions have been developed to date.

The Zoning Ordinance also specifies landscaping requirements which apply to all developments. Ten percent of the net site area (apart from thoroughfare rights-of-way) must be developed as landscaped open space located in the front or side yards. For residential developments, retention/detention basins may not be included in the open space area calculation. For commercial or office developments, however, half of the required 10 percent open space area may be provided through gradually sloping sides slopes for retention and detention basins. This provision provides an incentive for designing basins which are integrated into the landscaping design of the development (as opposed to fenced basins with steep slopes).

Open space preservation and landscaping concerns have also led Troy to advocate open storm drains in residential developments whenever possible. Although open drains utilize more land than enclosed drains, they typically provide attractive natural features in the residential development design and save construction costs as well as public maintenance costs.

The regulations of the City relating to open space preservation have important stormwater benefits, since they provide grassed areas which slow and absorb stormwater runoff. The stormwater and water quality benefits, however, are not explicitly stated in adopted regulations.

Environmental Impact Statement Requirements:

Environmental impact requirements are specified in the Troy Zoning Ordinance. An Environmental Impact Statement (EIS) is required in conjunction with large developments, including the following instances:

1. When a project is proposed using public funds which significantly affects the quality of the human environment;
2. When a project is proposed which, in the opinion of the city manager, significantly affects the municipal service systems (including storm drains);
3. When a development proposal constitutes a substantial departure from the intent of the Master Land Use Plan; and
4. When required by the City Code or required by the City Planning Commission in order to assist in their consideration of a particular development proposal.

An impact analysis on systems (including storm drains and retention facilities), services, economics, and the natural and social environment is required. The environmental impact statement makes the potential effects of the proposed development clear before decisions are made by the City.

Operations and Maintenance Programs

The City of Troy has a system of improved county drains which covers approximately half of the total area of the City. The intent of the City is to serve the entire City with improved closed or open drains. Due to financing problems, however, it is possible that improved drains will not be constructed in the western areas of the City.

The City of Troy has a public works maintenance program which provides maintenance for certain retention facilities and storm drains. If a retention or detention basin is part of a residential or industrial subdivision, it may be deeded to the City of Troy. The City requires a permanent maintenance deposit which is then invested. The interest on the fund pays for the cost of maintenance. The maintenance deposit must be sufficient to provide $600 for each acre of retention each year (assuming interest at 6 percent). Maintenance includes cutting grass, removal of trash, and small repairs to insure proper functioning. Sediment removal has not been necessary to date, although it is expected to be needed in the future. Approximately 100 retention/detention basins are presently maintained by Troy.

An alternative to maintenance of retention/detention basins by the City of Troy is the assignment of maintenance to a homeowners' association, either in a residential or industrial subdivision. In such cases, the City enters into an agreement with the landowner which defines the responsibilities. Typical maintenance agreement provisions include the following:

- The association shall be responsible for the proper maintenance of the retention pond and greenbelt easement areas in good order and appearance and for compliance with provision of the agreement.

- The association shall have the authority to establish rules, regulations, and policies pertaining to the maintenance of the retention pond and greenbelt area which shall be binding upon the lot owners, and shall have the authority to levy assessments against the members in order to provide for such maintenance.

- In the event that the association shall at any time fail to maintain the retention pond or greenbelt area in reasonable order and condition, the city may serve written notice upon the association setting forth the manner in which the association has failed to maintain the retention pond or greenbelt area in reasonable condition, and such notice may include a demand that deficiencies of maintenance be corrected within ten days.

- When it is determined that the association is able to maintain the retention pond or greenbelt area in reasonable condition, the City shall cease the maintenance.

- The cost of such maintenance by the City shall be charged to the association, and if not paid shall be assessed against the various owners of lots within the subdivision. The assessment to each owner shall bear the same proportion to the total assessment as the number of square feet of land owned by such owner bears to the total number of square feet of private land within the subdivision. The amount assessed against each owner shall become a lien on the lots of such owner.

- The City may enter upon the retention pond area at any time for the purpose of inspection and emergency repairs.

Agreements in the City of Troy do not specify in detail the maintenance activities which must be carried out by the association. Most maintenance activities to date have involved cutting of grass, removal of weeds, and trash removal. Experience with associations has been mixed -- some associations have completed maintenance tasks very well while others have not done a thorough job.

PART III: INNOVATIVE APPROACHES TO STORMWATER MANAGEMENT

Self-Help Rearyard Drain Program

In the early 1970's, it became apparent to Troy officials that flooding and drainage problems in existing subdivisions were a nuisance and concern to residents. A self-help rearyard drain program was initiated by the City to address the problem.

Under the program, the City provides equipment and technical advice to homeowners interested in in constructing backyard underdrains. The labor for the project is supplied by homeowners on weekends. The underdrain system consists of a 6" perforated pipe seated in a bed of pea pebbles. The drains are placed in rearyard swales and covered with sod. Catch basins provide for the collection of rearyard stormwater and entry to the drain system. The backyard drains then connect to large drains capable of handling the additional stormwater. The program has been popular with City residents and has provided relief to localized flooding. As required by the City's engineering design standards, similar rearyard underdrains are constructed in virtually all new residential subdivisions.

City-Financed Stormwater Retention Area

A five to ten acre lowland site was acquired by the City of Troy for use as a stormwater detention area. The site was acquired in 1974-1975, and is located in Section 4 downstream from Glen-Moor Estates. The site was acquired for two reasons: (1) to alleviate some existing flooding problems, and (2) to serve as a stormwater retention area for a new subdivision. The City determined that it was a more effective use of natural and financial resources to take an active role in site acquisition than to require a separate stormwater retention or detention facility within the subdivision.

The stormwater detention area is, in effect, an in-line basin. A small impoundment was created by means of a concrete wall. The impoundment provides additional storage capacity in the swampy area.

Financing for land acquisition was provided through the City's general fund. A substantial financial contribution for the construction of storm drains leading from the new subdivision to the retention and detention area was provided by the developer. The City is responsible for maintenance, although no maintenance has been required to date.

For Further Information:

Mayor Richard Doyle
City of Troy
500 W. Big Beaver Road
Troy, MI 48084
(313 524-3300

Mr. Laurence Keisling
Planning Director
City of Troy
500 W. Big Beaver Road
Troy, MI 48084
(313) 524-3300

Mr. Robert Quigley, City Engineer
500 W. Big Beaver Road
Troy, MI 48084
(313) 524-3300

Mr. Richard Graham
Vice President, Professional
Engineering Associates
950 N. Hunter
Birmingham, MI 48011
(313) 642-8202

FOOTNOTES: APPENDIX A

[1] The original design capacity of the Henry Graham drain outlet was 5000 cfs. If Red Run improvements are made, it would be possible for the City of Troy to use the full capacity and abandon retention and detention basins. Since a number of basins in the City are attractive landscape features, however, it is unlikely that basins would be abandoned in all cases.

APPENDIX B: BIBLIOGRAPHY

Preceding page blank

APPENDIX B: BIBLIOGRAPHY

Collins, Peter G. and James W. Ridgway, Urban Stormwater: Its Quality and Management, Southeast Michigan Council of Governments, 1978.

Michigan Department of Natural Resources, Managing Stormwater for Recreation; A New Approach, 1978.

Morrison, David, Jr., The Impact of Development of Wetlands on Water Qualilty, Southeast Michigan Council of Governments, 1979.

Poertner, Herbert G., Stormwater Management in the United States: A Study of Institutional Problems and Impacts, prepared for the U.S. Office of Water Research and Technology, September, 1980.

Proceedings from the Conference on Stormwater Management, sponsored by Michigan State University, Rouge River Watershed Council, Michigan Department of Natural Resources, Southeast Michigan Council of Governments, and the Office of Water Research and Technology, October, 1980.

Residential Stormwater Management; Objectives, Principles, and Design Considerations, published jointly by the Urban Land Institute, The American Society of Civil Engineers, and the National Association of Home Builders, 1975.

Southeast Michigan Council of Governments, Water Quality Guidelines for Development Plan Reviews: A Handbook for Local Officials in Southeast Michigan, October, 1980.

Preceding page blank

ACKNOWLEDGEMENTS

The Southeast Michigan Council of Governments (SEMCOG) wishes to thank local officials, staff, and consultants in the selected case study communities for their assistance on this project. The assistance of the SEMCOG Urban Nonpoint Advisory Committee in developing criteria for effective local stormwater management programs is also gratefully acknowledged.

SEMCOG Urban Nonpoint Advisory Committee:

John Gannon, Chairman
Charles Biegun
Thomas Borton
David Bradbury
Glenn Brown
Marcie Colling
Katherine Cushman
Philip W. Dondero
Lyle Duke
Dean J. Elwart
Thomas Hoogerhyde
Peggy Johnson
Donald Juchartz
John H. Kennaugh
John E. Kinville
Dale Monteith
Gerald Odom
Bette O'Shea
Frank Reynolds
John G. Sobetzer
Joanne Soronen
Dr. Paul Tomboulian
Helen Willis